A MAN OF SCIENCE AND SPIRITUALITY

Dr. Dayanidhi Patnaik, Ph.D (Cantab)

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This Book was released on the occasion of Dr. Dayanidhi Patnaik Birth Centenary Celebration

by

Prof. Ishan K Patro,
Vice-Chancellor, Ravenshaw University, Cuttack

In the August presence of

Prof. Goverdhan Mehta, FRS, FNA
Former Director, Indian Institute of Science, Bangalore
&
Former Vice-Chancellor, University of Hyderabad

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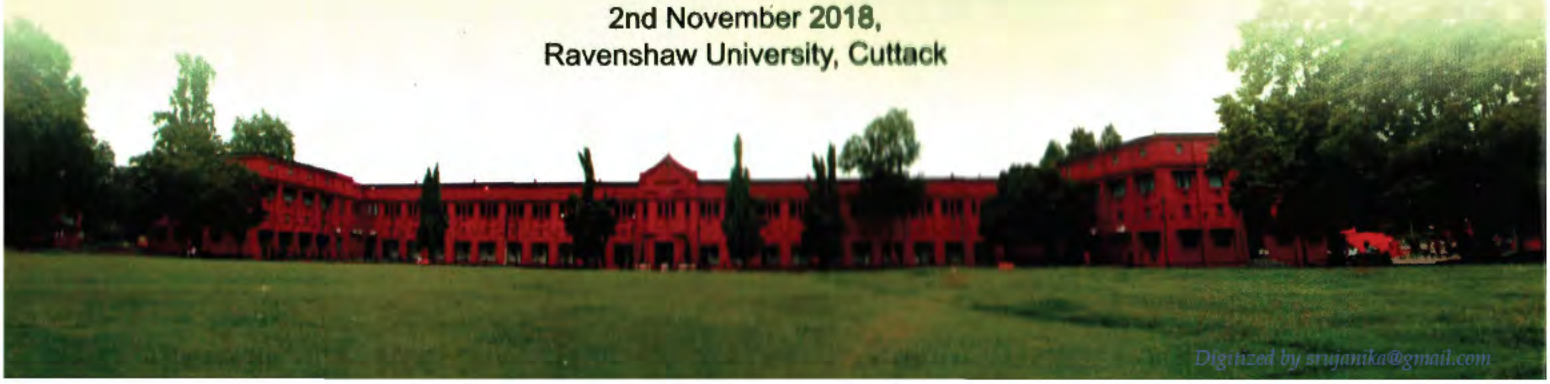
on
2nd November 2018,
Ravenshaw University, Cuttack



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A MAN OF SCIENCE AND SPIRITUALITY

Dr. Dayanidhi Patnaik

Birth: November 2, 1918
Death: November 26, 1985

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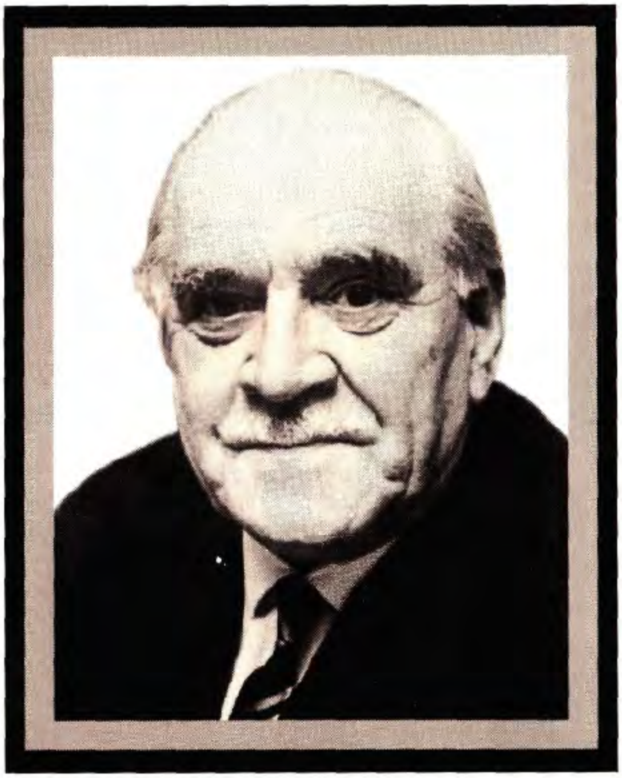
Dedication

This book is dedicated

to



Prof. Ronald GW Norrish, FRS, Nobel Laureate
Department of Physical Chemistry,
University of Cambridge, UK

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Professor Dayanidhi Patnaik, PhD (Cantab)

A Brief Profile

Professor Dayanidhi Patnaik was born in a highly illustrious family in the Princely State of Dhenkanal on November 02, 1918. His Great Grandmother Late Sulaksyhana Devi was the First Poetess in Odia language. Late Nityananda Pattanayak was his Great Grandfather. Dayanidhi's Grand Father Late Jagannath Pattanayak was the 'Bebarta' in Dhenkanal Princely State and was a great personal friend to the then Dhenkanal King Late Dinabandhu Deo Mahendra Bahadur, later the saviour of the kingdom. His father Late Shyama Sunder Patnaik had obtained the B. A. Degree in 1900 from Calcutta University. He declined the offer of Dewan-ship of Dhenkanal state as well as Deputy Collector position in British Government and joined their Education Department as Inspector of Schools. Dayanidhi was the sixth among the eleven siblings and the third among the four brothers who grew to adulthood. They are in seriatim: Late Kishori Mani Mohanty, Late Soudamini Pattanayak, Late Bidyutlata Pattanayak, Late Dr Satchidanand Pattanayak, Late Hara Mohan Pattanayk, Late Dayanidhi Pattanayak, Late Indulata Pattanayak, Late Manorama Pattanayak, Late Binodini Mohanty, Late Birajamani Pattanayak and Late Bijayanand Pattanayak. Dayanidhi's Mother Late Haramali Devi had been in the family way for a record 27 times, of which only 11 children grew to adulthood. Dayanidhi was very much coddled both by his mother Late Haramali Devi and Grandmother Subhadra Devi in his childhood.

Dayanidhi was home tutored till the age of eight. He then joined Dhenkanal High School in 1927 as a highly meritorious student. He was equally good at sports, particularly in football and hockey.

While in the school, he was nationally minded in response to the call given by Mahatma Gandhi and Pandit Jawaharlal Nehru. He initiated the 'Gadajat Movement' while in his 8th class, pursuant to which he was expelled by the King from the Ex-state of Dhenkanal. He had to shift to Pyari Mohan Academy, Cuttack, under Patna University, from where he did his Matriculation in 1934. Thereafter, he joined Ravenshaw College, Cuttack, under Patna University for his Inter Science and B.Sc programmes. He represented Ravenshaw College both in football and hockey. In his final year, he suffered multiple fractures in his legs while he was playing for the college football team. He did his I.Sc. and B.Sc. (Hons.) in Chemistry from Ravenshaw College, Cuttack under Patna University in the year 1936 and 1939 respectively.

After obtaining his Master's Degree in Chemistry (Physical Chemistry as Special Paper) from Patna University in the year 1941, he joined the Department of Chemistry Ravenshaw College, Cuttack as a Member of the Faculty in 1941. After a few years of teaching and research work, he went to Cambridge University in June 1947 and worked in the Department of Physical Chemistry under the supervision of Professor RGW Norrish, FRS for his Ph.D. on the "Effect of Light on the Combustion of

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Hydrocarbons" from April 1948 through March, 1950. His work unequivocally established that light has profound influence on the reaction intermediates and products as well on the course of the reactions and its kinetics. These studies led to investigations on "Flash-Photolysis" for which Prof. Norrish and his co-workers won Nobel Prize in Chemistry in 1967.

After returning to India in 1950, Professor Patnaik worked on various facets of Chemistry including Chemical Kinetics, Photo-Chemistry of Uranium and Rare-Earth Elements, a Research Project of National Importance in the field of Nuclear Energy. He was an Excellent Researcher and a Loving Teacher. For him the instruction was never over till the last student of the classroom has not imbibed the concept of chemistry fully. His students have great love and respect for him long after his departure from this mundane world.

In 1963, he left Ravenshaw College and plunged into 'Sarvodaya Andolan' pioneered by Shri Binova Bhave and spent his remaining life for the upliftment of the farmers, poor and the downtrodden. He came to be known as "Haryana Gandhi" and supported the Sarvodaya Movement through various activities in many parts of the country.

He came back to Odisha after 22 years and settled down at his birth place, Dhenkanal and devoted his time in the service of the poor, the leprosy patients in particular. He opened a centre for Homoeopathy where he gave medicines to all patients. He was unmarried and was single throughout his life. He was a Physical Chemist Extraordinaire and will be remembered for time immemorial among the Chemical Fraternity of the World.

He breathed his last on "Bada Osha" day on 26th November, 1985.

❐

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भारत के उपराष्ट्रपति

VICE-PRESIDENT OF INDIA

MESSAGE

I am happy to know that Orissa Chemical Society is celebrating the 1st birth centenary of Professor Dayanidhi Patnaik (1918-1985) during October – November, 2018.

Born at Dhenkanal in a traditional and cultured family, Professor Dayanidhi Patnaik had graduated from Ravenshaw College, Cuttack and received his Masters Degree in Chemistry in 1941 from the Patna University. The ensuing assignments of Professor Dayanidhi Patnaik spoke about his contribution in several areas like ion-solvent interactions, photochemical preparation of uranium compounds and chemical kinetics. His association with Sarvodaya Movement of Acharya Vinoba Bhave showed his concern towards the welfare of the poor farmers of India.

I convey my greetings and best wishes to Orissa Chemical Society and wish the event a grand success.

(M. Venkaiah Naidu)

New Delhi
31st August, 2018

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Prof. (Dr.) Trilochan Pradhan, Padmabhusan
Former Director, Institute of Physics
&
Former Vice-Chancellor,
Utkal University, Bhubaneswar

Message

My Teacher Dr. Dayanidhi Patnaik

Among good teachers Dr. Dayanidhi Patnaik was an exception. He was not only good, but also an inspiring teacher. Talking to him on any issue was an inspiration.

It looks he was born to play a greater role than that of a teacher. He was not satisfied with being a teacher and a researcher; he felt that society needs his intervention. So he left teaching and joined the Sarvodaya Movement of Acharya Vinobha Bhabe to help poor farmers where he was as successful as a teacher so much so that he became known as "Haryana Gandhi".

I congratulate Dr. Dayanidhi Patnaik Memorial Trust, Orissa Chemical Society and Department of Chemistry, Ravenshaw University for celebrating his Birth Centenary.

(Trilochan Pradhan)

Bhubaneswar
October 22, 2018

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From the Editor's Desk...

It is a matter of great pride for the entire scientific community of the state of Odisha that Dr. Dayanidhi Patnaik Memorial Trust, Bhubaneswar is organizing Prof. Dayanidhi Patnaik Birth Centenary Celebration in collaboration with Department of Chemistry, Ravenshaw University, Cuttack under the aegis of Orissa Chemical Society, the highest professional body of Chemists in the State. The Department of Chemistry, Ravenshaw College was established in the year 1906 and for the first time in the history of the department, Birth Centenary Celebration of any Professor is celebrated and that too in a magnanimous way. Prof. Dayanidhi Patnaik was Professor & Head of the Department of Chemistry, Ravenshaw College from 1954 to December, 1961.

Prof. Dayanidhi Patnaik was born on 2nd November, 1918 at Dhenkanal. After completing his M.Sc in Chemistry from Patna University in the year 1941, he joined the Department of Chemistry, Ravenshaw College in the same year as a member of the faculty. Later in the year 1947, he went to Cambridge University for his PhD programme under the guidance of Prof. R.G.W.Norrish, FRS on the **"Effect of Light on the Combustion of Hydrocarbons".** After successfully completing his PhD in the year 1950, he came back to Ravenshaw College in the same year. His research work unequivocally established that light has profound influence on the reaction intermediates and products as well as on the course of the reaction and its kinetics. These studies led to investigations on **"Flash Photolysis"** for which Prof. Norrish and George Porter won Nobel Prize for Chemistry in the year 1967.

Time passed by. In the year 1963, Prof. Dayanidhi Patnaik emerged in to public arena and joined Sarvodaya Movement led by Acharya Vinoba Bhabe and made significant contributions for uplifting the condition of the poor farmers of India for which he was popularly known as "Haryana Gandhi". After long 22 years, he came back to Odisha in August, 1985 and settled down in his birth place, Dhenkanal and devoted his time for the service of the poor, the leprosy patients in particular. He was unmarried and was single throughout his life. He was a Physical Chemist Extraordinaire and will be remembered for time immemorial among the Chemical Fraternity of the World for his Outstanding Contribution to Physical Chemistry. He breathed his last on 26th November, 1985.

The idea of bringing out of such a publication, that too in the form of a book, was conceived by Prof. Balaram Sahoo, Former Professor of Chemistry, IIT, Kharagpur and Chairman of Dr. Dayanidhi Patnaik Memorial Trust which was readily agreed by Prof. Prashant Kumar Pattnayak, Former Professor of Metallurgy & Materials Science, IIT, Bombay and Managing Trustee of Dr. Dayanidhi Patnaik Memorial Trust and other members of the Trust Board.

Prof. Balaram Sahoo is considered as the Intellectual Heir of Dr. Dayanidhi Patnaik under whom he worked for many years in the Department of Chemistry, Ravenshaw College, Cuttack. Even Prof. Balaram Sahoo and Prof. Dayanidhi Patnaik of Department of Chemistry, Ravenshaw College jointly authored a research paper entitled "**Carbonates of Uranium"** which was published in NATURE, Vol. 185, No. 4714, p. 683 only, March 5, 1960. The Editorial Board was tempted to reproduce this paper in this book for knowledge of all readers. The Editorial Board has also reproduced

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another paper in this book entitled **"Effect of Light on the Combustion of Hydrocarbons"** jointly authored by Prof. R.G.W. Norrish, FRS and D. Patnaik, Department of Physical Chemistry, University of Cambridge, which was published in NATURE, Vol. 163, No. 4153, June 4, 1949, pp 883-885.

The Editorial Board was also pleased to reproduce another two important papers of Prof. Dayanidhi Patnaik in this book for kind information & wider circulation among the readers. They are: (i) The Distribution of Lower Fatty Acids between Water & Variety of Solvents (Abstract), J. Chem. Soc., 1951, pp 1249-1252 by Mansel, Davies, Percy Jones, D.Patnaik and E.A. Moelwyn- Hughes, University of Durham, King's College, New Castle-on-Tyne, 1. (ii) The Photolytic Preparation of Uranium Tetrafluoride, Proceedings of the Indian Academy of Sciences, Vol. XLIX, No. 4, Sec. A, 1959, pp200-202 by D.Patnaik and Balaram Sahoo, Department of Chemistry, Ravenshaw College, Cuttack-751003.

The Editorial Board was proud to receive a Message from His Excellency the Hon'ble Vice-President of India Sri M. Venkaiah Naidu for publication in the book and will remain grateful to him for the same. The Editorial Board also thanks Prof. Trilochan Pradhan, Former Director, Institute of Physics & Former Vice-Chancellor, Utkal University, Bhubaneswar for contributing a Message in the book in honor of Prof. Dayanidhi Patnaik, his revered teacher in Ravenshaw College.

The Editorial Board owes its gratefulness to all the Professors, Writers, Research Scientists, Scholars & Students of Prof. Dayanidhi Patnaik who have taken pains in contributing articles for publication in the book. Constant guidance, cooperation and assistance received from all quarters in bringing out the publication are gratefully acknowledged. The Editorial Board also thanks all Students, Teachers and Authorities of Department of Chemistry, Dhenkanal Autonomous College, Dhenkanal and Department of Chemistry, Ravenshaw University, Cuttack in organizing two Regional Conferences in honor of Prof. Dayanidhi Patnaik during the Birth Centenary Year-2018 and contributing reports of such Conferences along with Scientific Posters which have added value to the publication. The Editorial Board also thanks Members of Dr. Dayanidhi Patnaik Birth Centenary Celebration Committee for reposing faith in them in bringing out this publication.

Special thanks goes to Orissa Chemical Society, particularly to the President Prof. Asutosh Samantaray, Former Professor & Head, Department of Chemistry, College Basic Science & Humanities, OUAT, Bhubaneswar and Authorities of Department of Chemistry, Ravenshaw University, Cuttack for joining hands with Dr. Dayanidhi Patnaik Memorial Trust, Bhubaneswar in organizing Dr. Dayanidhi Patnaik Birth Centenary Celebration in Ravenshaw University, Cuttack on 2nd November, 2018 and assigning responsibilities to the Editorial Board in bringing out this publication.

Editorial Board also thanks Dr. Dayanidhi Patnaik Memorial Trust, Bhubaneswar for publication of the book. Thanks are also due to Sri Akshaya Das, Proprietor, AD Graphix, Bhubaneswar for undertaking the responsibilities of designing & printing of the book in a very short time.

(Dr. Chitta Ranjan Mishra)
Executive Editor
&
Trustee, Dr. Dayanidhi Patnaik Memorial Trust, Bhubaneswar

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Professor Dayanidhi Patnaik - A Biographical Memoir

Prof. Prashant Kumar Pattnayak

Professor Dayanidhi Patnaik, popularly known as 'Dr. Patnaik', was born in the princely state of Dhenkanal on November 2, 1918 in a highly illustrious family. His great grandmother, Sulakshyana Devi, was the first Odia poetess, hugely acclaimed by her contemporaries like Madhusudan Rao, Radhanath Ray and Nanda Kishor Bal. His grandfather, Jagannath Patnaik, was the saviour of State holding the Court of Wards for sixteen years and later the guardian angel of the royalty. His father, Shyama Sundar, after obtaining his B. A. degree from Calcutta University in 1900, declined to head the State administration also the position of Deputy Collector in British Government but joined their Education Department.

Dayanidhi was the sixth among the 11 siblings who grew to adulthood, third of the four brothers. While the eldest brother, Satchidanand was naturally highly pampered Dayanidhi was also equally coddled; he had endless pranks for his mother and grandmother. He was very fond of `ghee' (clear butter) and the mother had always an extra helping of it for him for lunch and dinner.

Childhood:

In the absence of the father, away in British Government employment, the three brothers were brought up under the tutelage of Shri Basudeb Pattanayak, a classmate of their father and a teacher in the Dhenkanal High School. The two elder brothers were tutored both morning and evening by the tutor and it was but natural for Dayanidhi to walk into the class. He used to sit in the lap of the teacher while the brothers did their lessons.

He had a formal initiation to learning, 'Vidyarambh' at the age of four in 1923. Both the pupil and the teacher wore new dhotis. He was very comfortable in his dhoti even as a four-year old and loved wearing it all his life.

After the ceremonial initiation the teacher presented the pupil a slate and a pencil to scribble on, whereafter he grew very respectful for the teacher and did not sit on his lap any more and attended the class with great pleasure.

Young Dayanidhi from his early childhood had displayed his independent, logical thinking. When teacher Basudeb constructed the table of two to show him multiplication as a process of repeated addition, the pupil produced the tables up to ten next day to the great pride of the teacher. In less than a year he was ready with tables up to 25. He had an extremely sharp memory which pleased the teacher immensely.

Childishness:

Dayanidhi was a highly sedate and disciplined child. Acts of his naughtiness were so few and far between that the following episode has been repeated over and over again.

Uncle Suryamani had taken up selling of ration items like sugar. Once perchance several bags of sugar got drenched in rain and were being dried in sun on the rooftop spread on mats. Suryamani's

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younger brother Brahmnand was contemporary of the nephew. The two never went to the rooftop alone as the parapet walls were rather low. But on this occasion they had strayed unto the rooftop. After having their fill in sugar they rolled on it in their knickers, covered all over even including the eye-lids.

They were enjoying themselves in a bed of sugar while they were being searched for helter skelter, when somebody went to the rooftop to discover two tiny sugary demons. There was no other way to clean them than a second bath for them. Uncle Brahmanand being mentally retarded, Dayanidhi bore the reprimand. Other than this sugar episode, his riding of stray horses when in the school was the only other wayward activity he had been accused of.

Schooling:

Basudeb Pattanayak had a highly disciplined and beautiful handwriting, both in Odia and Roman scripts which the young student imbibed early in his life. He maintained this neat hand till his last. His handwriting at Cambridge in 1948 and that at Dhenkanal in 1985 before his demise were almost identical.

Taught by some British trained teachers in the Dhenkanal High School in their time both father Shyama Sundar and teacher Basudeb had more English-like in their pronunciation, notwithstanding English is pronounced in 32 different ways in the 32 British counties. Dayanidhi imbibed these and spoke more English-like fashion; later in life this might have contributed to his being described as 'Saiba.' Much later when tutoring his nephews and nieces at Dhenkanal teacher Basudeb inculcated in them the right movement of lower lip and tongue in pronouncing different syllables.

Indian names were transliterated into English with various spellings. The surname `Pattanayak' was spelt differently by different people. Dayanidhi inherited from his teacher, among others, the spelling of his surname -- `Pattanayak' which was entered in the school admission register, obviously by the tutor; the father however spelt it short as `Patnaik.' He carried the long spelling all through and was registered at Cambridge with this surname. Apparently at the behest of Professor R.G.W. Norrish (his Ph.D. supervisor) he shortened it to his father's spelling 'Patnaik.' It has been spelt both ways in his Ph. D. thesis.

In the school his progress was steady under the supervision of the personal tutor. Under the cool exterior, however, there was an undercurrent of nationalism.

Sports:

While he showed interest in all sports he was particularly fond of horse-riding. Satrughna (Satura by petname), his personal attendant used to catch hold the stray horses and both used to go riding without saddle or bridle for hours. Sometimes his elder brother Harmohan also joined them. This was one of the rare waywardness displayed by him.

While football was his favourite sport, he participated in hockey and baseball, the other two outdoor games organised in the High School. (House of Dhenkanal were baseball enthusiasts and provided the school with adequate facilities, even after loosing their kingdom.) He continued with football and hockey in college and university. He captained Ravenshaw in both the games. In a football match against the then arch rivals, Cuttack Medical School, during his fourth year of B. Sc. programme in 1937 he suffered multiple fractures in his legs and was bedridden for several months and lost a year in his studies; but continued with the sport unabated. He had the ultimate satisfaction of scoring the winning goal against the same rivals the next year to secure the league championship for Ravenshaw.

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School Activities:

The Headmaster of the school, Shri Rajendralal Dutta had great love for debating. At his behest all the three brothers excelled in it and were voracious readers.

Though in the Shankar Pratap Mahindra Bahadur's regime newspapers were prohibited in the State of Dhenkanal, the father ensured that the children were abreast the events of the time; newspapers were brought from Cuttack as waste, packing material. Dayanidhi heeded the call given by Gandhi and Nehru for the freedom movement.

Social Conscious:

In the year 1930 while in Class VIII he initiated the 'Praja Andolan', initially in the state of Dhenkanal which later spread all over the Gadajats, the ex-states of Odisha, which eventually ended up in the murder of the British Political Agent to Odisha Littoral States. His personal friend and classmate, Baishnab Patnaik, who dropped out from the school (the fire-brand Communist leader and M. P. of later years, who passed away in 2016), as his propaganda outlet among the poor and distressed. Elder brother, Harmohan joined and the movement gathered critical mass for which both brothers were expelled by the King. Father Shyam Sundar was sent words on 1931 August 23 evening that the School office had been kept open and he could collect the transfer certificate of his two sons, Harmohan and Dayanidhi, before sunrise next day, for thereafter they would be rusticated from schools in Orissa. Dayanidhi joined Pyari Mohan Academy at Cuttack while Harmohan joined Olasing High School. It is to be understood that in reality of facts Dayanidhi is the originator of the famous 'Gadajat movement' to which Shri Sarangadhara Das was implanted later on and made the President in view of his age.

College and University:

But the severe reprimand made a deep impact on Dayanidhi. He left the agitative mind in favour of serious studies. Passing his Matriculation in 1934 with flying colours, partly erasing the apparent stigma attached to the compulsory transfer, he joined Ravenshaw for his InterScience programme and later opting for Honours in Chemistry in the B.Sc. programme. Dr Balabhadra Prasad had by then joined Ravenshaw after his Ph. D. from London University. From his first year at Ravenshaw Dayanidhi had become a favourite student of Dr Prasad.

While appearing at the University Examination for his B. Sc. in 1939 Dr Prasad had lent his watch to Dayanidhi for the examination, which he unfortunately lost. While coming back from UK he dropped at Switzerland to get a 'Rolex Oyster Perpetual' watch for his guru. When he presented it to him, the Guru promptly opened the case and wrapped the watch on Dayanidhi's wrist with the 'command' "This Oyster shall perpetually roll on this wrist." Dayanidhi wore it for a long time till the early eighties.

After graduating in 1939 he joined the Patna Science College, the University College, for his M. Sc. in Chemistry. He took Physical Chemistry as his special subject in which he made some special studies in Chemical kinetics, Photo-chemistry and Electro-chemistry.

Though he did not stand first in the class his teachers, Dr PB Ganguli, D. Sc. (London), Professor of Chemistry (and later the Principal) and Dr AC Roy, D. Sc. (London), Professor of Chemistry, strongly vouched for his knowledge in theory and extremely good practical hand in recommending for higher studies/research, in those days naturally in England. In 1941 he passed his M. Sc. and joined his Alma mater, Ravenshaw College on the faculty.

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After the completion of his studies he diverted some attention to the domestic front. He started taking care of the landed property off Dhenkanal town. He instructed field workers in fine care of the cultivation, timely ploughing, sowing and other stages, considering the weather conditions. He also took care of the health of the workers. As a result year after the produce was good. When he left for England in 1947 he left behind about 40 tonnes of paddy in the granaries even after sell of paddy to pay for his voyage to England. Needless to say that the produces dwindled soon after.

Alma Mater:

Apparently some of his teachers at Ravenshaw, subsequently colleagues, were not appropriately dressed, some in dhotis, which had been commented upon by the British Professors. This had made an impact on Dayanidhi. On joining the Ravenshaw faculty he took to stylishly dress himself in suit and tie, notwithstanding his comfort in dhoti since early childhood. Many of his friends and colleagues used to call him 'saiba' in mock seriousness. His classmate and colleague in the Department of Chemistry, Raj Kishor Mishra always addressed him so. He had a suitcase-full, nearly a hundred ties when he returned from Cambridge.

Initiation to Research Work:

Soon after joining the faculty at Ravenshaw, with due deference his mentor, Dr Prasad, he started some investigative work on the activities from solubility measurements. Though he had obtained some interesting results it was a pity that he could not continue with the studies under the pressure of lecture load and laboratory practical classes. He was also transferred to a college where the facilities were limited to InterScience level laboratory practicals only.

In addition to his studies in solubility, he also created facilities for work in Electro-chemistry, which his younger colleagues engaged for their experimental work -- training for research.

Sports Administration:

Having joined the faculty he took to sports administration, organising the games and sports and coaching in football and hockey teams both for local league and tournament as well as for university intercollegiate meets. With his background he soon was appointed as Vice-President, Sports. He organised intercollegiate games and sports and took the University teams to inter-university sport events. He organised an inter-university football tournament at Cuttack and got a sports goods manufacturer to sponsor it with quality footballs; the surplus balls were donated to the organising centre Ravenshaw College.

In his school days the large stretch of land opposite the Dhenkanal Court building was assigned to the High School and there were as many as six football fields for the students, one each for the senior classes VIII to XI and two for IV to VII. Having taken over sports at Ravenshaw he demarcated one international size field with posts and net for official matches and four more for practice games, for wider participation in the most popular sport for major part of the year. During winter two of these were converted into hockey fields with proper goalposts. With his care and coaching he had more than 50 regular hockey players to choose his team from.

He continued to serve as Vice-President till he left Ravenshaw College.

In the meantime he underwent a programme in Anti-gas Measures at the Civil Defence Institution at Calcutta and completed the course with a First Class in July 1943 as a civil defence exercise.

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Scholarship for Ph. D:

Dayanidhi realised that in order to be in academics one should carry out research and obtain a Ph. D. degree, and having done some rudimentary research work at Ravenshaw, he applied for a scholarship for higher studies/research in Cambridge University (UK). While recommending his application the then Director of Public Instructions (DPI) added one more name to make it appear that the Government selected one, from two candidates. As was expected Dayanidhi was awarded a scholarship of 300 Sterling pounds a year on study leave terms. Accordingly he applied to the High Commissioner for India in UK on 1946 January 21 requesting for admission to Cambridge University in October 1946 for the Ph. D. degree.

The Education Department of the Commissioner, however, wrote to Fitzwilliam House (later Fitzwilliam College), the seat of research in Physical Chemistry only on March 18 enclosing the Dayanidhi Pattanayak's application and the connected papers with a request to admit the candidate for the Michaelmas term in October 1946. By the time the Secretary of the Board of Research Studies could obtain the opinion from the Professor of Physical Chemistry, the Degree Committee had met for the last time for the that term. Therefore, it was not possible to confirm admission in the Michaelmas term before the month of May.

The Professor, however, offered to find accommodation for Pattanayak for a probationary period pursuant to which the Degree Committee was willing to admit him as a research student. The Secretary of the Board of Research Studies clearly indicated to the High Commission that in all probability he would be admitted as Research Student on a one-year probationary period, with provision for its curtailment, should the student prove worthy to take up his proposed research work.

In spite of all the cooperation extended by the University for Dayanidhi to join the Fitzwilliam House in October 1946 the bureaucratic 'babudom' stood on his way. At the home front too, the fact that he was to go to Cambridge for his Ph. D. was not kindly viewed. Most of his predecessors who had availed of the Government scholarship had returned with B. A. degrees from London or other universities, at the most with an M. Sc.

At the personal front, being considered as the most eligible bachelor also brought its attendant maladies. The top echelon in academic administrators vied with one another, one for his friend's daughter and the other for his own. While he was to proceed to Cambridge to join by beginning of the October 1946 he was transferred to Puri College.

To add further complication the then the top academic administrator did not sanction his leave although he had himself recommended Dayanidhi's application who had now been awarded a Government scholarship, on the flimsy pretext that they had recommended two persons and they both should go together. The Government, however, asserted that since only Dayanidhi Pattanayak has been awarded a scholarship he alone would go. That settled the matter.

Even then Dayanidhi's woes were not over. He was relieved from his duties at Puri by Government order on the same day as his booking for sailing from Bombay. The DPI purportedly commented that when going to Cambridge he should have chartered a plane take him to Bombay. Consequently Dayanidhi had to reschedule his sailing.

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Cambridge:

Finally he could report at the Fitzwilliam House on 1947 June 11. That was not the end of the hardship. The Government scholarship which had already been recommended by the same DPI was not released for over six months and subsequent payments were made in six monthly instalments. This had put Dayanidhi to severe financial crunch.

His eldest brother, Dr Satchidanand was on extended emergency war service and had the right to draw one half of his salary in Sterling pounds. Dayanidhi never let the brother know of his difficulties but bore it all by himself.

Dayanidhi sailed by a continental liner. He got accustomed to taking food using fork and spoon. Some of his contemporaries travelled by Indian ships. In the ship they continued to take food in the traditional fashion using fingers and did not get the habit of using fork and spoon. At Cambridge a South Indian research scholar used his fingers for dinner. One of the Cambridge dons who sat next to him started eating with his hand, obviously clumsily, lest the Indian scholar should feel embarrassed. In the company of other Indian friends the scholar soon got used to fork and spoon.

Long after when his nephews and nieces were staying with him in Ravenshaw College quarters he narrated this story when he found one of his nephews, the author herein, using fork and spoon at home. They, however, got used to fork and spoon taking food in the restaurants.

Having reported at Fitzwilliam in the mid-session he was put on probation and started working with Professor E. A. Moelwyn-Hughes. He made good progress with his work in Electro-Chemistry and communicated a paper for publication. He made a good impression with his working hand with highly reproducible results which attracted the attention of the Professors.

During the 1948 New Year Eve Ball, Miss Norrish, daughter of Professor RGW Norrish, came to know the young Indian Research Scholar. She understood that her new friend was highly desirous of working with her father for his Ph. D. and vouched with her father to take Pattanayak under his supervision, which he acceded to.

Dr Radha Nath Mishra, a family friend from Dhenkanal, went to join London Hospital for his FRCS. He carried with him a large quantity of ``Ladoos" made with pure cow ``ghee," a favourite of Dayanidhi. This speaks of Dayanithi's utmost love for pure cow ghee. A substantial part of the ladoos was consumed with relish by Mrs Norrish and family.

With a figment of their fertile imaginations, for, to learn that Dayanidhi has come to know the Professor's daughter was well neigh impossible, Dayanidhi's the two sisters-in-law used to tease their mother-in-law (Dayanidhi's mother) that he was so handsome, he would marry his Professor's daughter and come back with his English wife. The mother's dictum was if he came back with a 'mem' he would have to stay in the ``Chowpadhi" (the outer guest room); he would not enter the house.

In contrast to the contemporary belief Professor Norrish had postulated that formaldehyde was an important reaction intermediate generated during the combustion process and asked student Dayanidhi to investigate the effect of light on the oxidation of methane, ethylene and butane. He had to fabricate an elaborate experimental set-up in order to observe absorption bands of formaldehyde and other intermediates. He employed an intense source of radiation near ultra-violet region with a view to bring about photo-chemical changes in formaldehyde with attendant influence on the kinetics of the oxidation

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process. His studies unambiguously established that light has definite influence on the oxidation of hydrocarbons.

At that time S C Bhattacharya was working for his Ph. D. in Organic Chemistry section of the same Department though in another building. Naturally the two Indians in the same Department became extremely thick friends that helped each other to over come their loneliness. Cambridge used to become very dreary during term breaks. Both friends used to go swimming in the Canterbury river. Swimming in complete bare body in Canterbury was a regular adventure. While Bhattacharya was game for it Dayanidhi never agreed.

After his student days he had taken to sports administration. At Cambridge he started coaching the Fitzwilliam House hockey team. In course of time he started umpiring in matches. Once he was called upon to umpire in a cricket match. His acute observations and impartiality were so pronounced that he eventually officially umpired in the Oxford-Cambridge annual cricket match. The refrain was ``If 'Pat' has given you out you are plumb leg before."

He had learnt the British customs. On invitation by his Professor, for the Christmas dinner he had presented an image of Lord Buddha to Mrs Norrish. His coming forward to do the dishes after the dinner was greatly appreciated by her. He was a regular guest for Christmas during his days in Cambridge.

The reproducibility of the experimental results was highly gratifying. With a huge volume of highly reproducible and accurate experimental results for the small molecules of methane and ethylene on the one hand and for butane on the other, he could unequivocally established that radiation had a very definite influence on the reaction intermediates and final products and thence on the mechanism and kinetics of the combustion process.

He completed his thesis work by March 1950 and submitted the thesis for award of the degree in June. Interestingly Professor Norrish asked Dayanidhi why he had such a long spelling of his surname while his father's was just 'Patnaik' and on his behest the student took to the shorter version. In his thesis, however, his surname has been spelt both ways. Thereafter he has consistently used the shorter one.

Flash Photolysis:

The most important off-shoot of Dr Patnaik's research is Flash-Photolysis and Professor Norrish could easily visualise the significance of this. He strongly advised the student to continue with the offshoot of his work. But he was committed to return immediately after completing his Ph. D., which he did after a tour through Europe.

After his experimental work was completed while preparing his thesis he helped George Porter who had now joined the project on Flash-Photolysis in designing his experimental set-up and carrying out the pilot experiments and making modifications so as to overcome leakage in his vacuum system in his investigations on flash-photolysis. After getting Nobel Prize in 1967 Sir George had acknowledged this.

Return to India:

During his return journey to India, at some airport, though the booking was to West Berlin by mistake he was given boarding pass for a flight to East Berlin. He did not have visa to it and sat through the day at the airport. After returning to India he had to face some enquiry for it. Luckily he had preserved his air ticket and boarding pass to prove his innocence.

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He visited Switzerland to collect a Rolex watch for his 'guru' and an Omega for himself from the respective factory outlets.

On his return to India he had to undergo some 'penance' for having crossed the seven seas. He had to go to the native place Dhenkanal and before entering the house he was seated on a stone and seven married women poured seven pitcher-fulls of water each to wash his sins, with traditional 'aarti.' Then only he could enter the house to offer prayer in the puja room.

After paying obeisance to family elders, he came back to join Ravenshaw College as one of the very few with a Ph. D., that again from Cambridge University. As such he had always been well dressed even before going to England, now with his Cambridge flair and get-up, all the students and teachers alike addressed him as 'Dr Patnaik' and that stuck to him for all his life.

At Cuttack the family was still occupying the same old rented house in the Cosmopolitan Lane, a short walk from the college and he resumed his old practice of walking down.

He was left with some remnants of his Cantab habits, like midday lunch. He started coming home for lunch. But it interfered with his lecture hours. He then began carrying a lunch box but with rice meal it became messy. He wanted roti for lunch but the sister-in-law found it difficult. He soon fell back to his old ways.

Back at Alma Mater:

He wanted meat everyday. Other family members did not relish it daily. For a few weeks somebody had to go everyday to the market to get it and he did not like the idea. He found that taking a lunch at 10 in the morning gave him more time to utilise the services of the supporting staff in the laboratory for setting up research set-ups. He, therefore, fell back to his old practice of taking lunch and going to the Department at 10.

Having spent three years broad and coming back with a Ph. D. degree from no less than the University of Cambridge he became a centre of envy. He was over loaded with lecture and laboratory practical classes and did not get time for his own research work. He gave up any idea of resuming sports administration and coaching. Instead he stayed in laboratory after college hours for some undisturbed work. Soon he got some refreshments from local canteens and induced young colleagues to stay back. To start with he bore the cost of their small bites, but soon there was a tea club.

He was promoted to the post of Reader and allotted a college quarters on the campus. The eldest brother being in government service was transferred elsewhere. The second brother had shifted his seat of legal practice to native place Dhenkanal. So he shifted to the college quarters with only his parents and younger brother, Bijayanand.

The earlier occupants of a cluster of 4-houses had planted a large number of lemon trees and the houses were known as 'Lemon-orchard' houses. In course of time fences were planted and some of the lemon plants were left beyond the fences. Though the neighbours were not happy Dr Patnaik let people pluck lemon from these plants.

Younger brother, Bijayanand was studying in his B. Sc. junior year with Mathematics honours. On promotion to the next year he lost his honours. He was too good a student to loose his honours. It was interpreted that out of personal envy for the elder brother revenge has been perpetrated on the younger.

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The elder brother, therefore, advised the younger to leave Ravenshaw College and go elsewhere for his studies. He went to Allahabad University.

With the Department a small walk from the house and Dr. Patnaik could easily come back at 5 to look up the parents then go back to the laboratory for his research work. Thus this became a pattern and work progressed satisfactorily. More students opted to do their M. Sc. project with him with the well set and more modern laboratories.

Vikram Dev College:

One could say that this caught the attention of all who mattered. He was transferred to Vikram Dev College at Jeypore in Koraput, as the Principal on the pretext that one has to take up administrative responsibilities on promotion to higher position. This college had facility only for a few students in I. A., I. Sc. and B. A. and the assignment was entirely administrative. Obviously Dr. Patnaik felt fish out of water.

The story did not end there. An investigation committee of three very senior teachers of the state, including the Principal of one of the Christian colleges in Cuttack, was asked to look into some allegations, maladministration and misappropriation of government funds by the Principal, Dr. Patnaik. After a thorough, systematic investigation and writing their report, the committee members took Dr Patnaik into confidence and had a detailed personal talk where they found that after getting all the training to conduct and supervise research he was rotting in this I. Sc. college purportedly because he started his research at Ravenshaw. The reverend Principal impressed upon the Committee to strongly recommend to the Government that Dr. Patnaik be transferred to Ravenshaw College so that he could utilise his expertise in research.

One could say that the Government felt obliged to transfer Dr. Patnaik back to Ravenshaw. And back in his home turf he restarted his efforts for research in all earnest.

Back at Ravenshaw:

Dr B Prasad was the Head of the Department of Chemistry and opted out from becoming the Principal as it would have told upon his research. The next senior most Professor Dr Golakh Bihari Banerjee took the position. With the new dispensation Dr Prasad was apparently burdened with thankless administrative assignments that equally hampered his work. When the DPI position got free he opted for for it. Although Dr Guha-Sarkar became the Head, the management of the Department in fact was left to Dr Patnaik who was to take over on Dr Guha-Sarkar's imminent retirement.

Finding that he had a fairly long tenure he started to build the Department with more modern facilities and refurbished the existing ones. The fuel-gas generated from kerosene had always been a problem, likely from theft of the fuel. With his own honesty he impressed attendants to do their best in the interest of the students. With the same quantity of kerosene the burners never failed the students. The attendants would start their gas plant early in the morning for the 9-30 AM laboratory practical classes.

The glass blowers came forward to re-fabricate the glass ware like pipettes and burettes cutting down in glassware expenditure. Students also paid less breakage charges. They carried more intricate fabrications required for research set-ups, many involving diffusion vacuum pumps.

Funds were sought for and sanctions were carefully used in procurement of more modern appliances and equipment for measurement and control. Grants from many government and other sources helped in making Ravenshaw Chemical Laboratories some of the best in the country.

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Besides Dr. Patnaik two more research sphere-heads were established with Dr. M K Raut in Organic and Dr. Sukumar Aditya in Inorgnic Chemistry. In addition to M. Sc. projects, a large number research scholars joined the Department.

Faculty members coming back with Ph. D.'s abroad introduced more modern courses. Most of the post-graduate courses were also revised and made up-to-date. Being the only college under the University offering Honours and M. Sc. programmes in Chemistry bringing about changes and modernisation were possible and welcomed.

In the University matters, although there were may big mouths, the self-proclaimed guardians of Constitution of the country and of the University, but soft-spoken Dr. D Patnaik had his points were always well taken. With Professor P K Parija, the Vice-Chancellor, also a Cantab don, there were allegations that one Cantab man had a soft corner for the other Cantab man. But most often Dr. Patnaik had the last word.

Heading the Department:

With Dr. Guha-Sarkar formally retiring Dr. Patnaik took over as the 'de facto' and 'de jure' head of the Department. By the old tradition of the Department Dr. Patnaik as the senior most faculty member started taking classes for the junior most class, the First year of the then I. Sc. programme. Any student of that time shall never forget the efforts with which Dr. Patnaik explained the concepts in basic Chemistry. None of his ex-students has forgotten his description of the gigantism of Avogadro number (6.023×10^{23}) as the number of buckets of water that pass through the Jobra barrage every year.

In addition, he taught the Third year class (the junior students) of B. Sc. both Pass and Honours programmes, besides his M. Sc. classes. In a way he had a lion's share in the teaching of theory courses in the Department. He preached the spirit of teaching by practice and not by mere words.

He felt himself responsible for whatever happened in the Department. Invariably the students in the practical class threw the waste filter paper in the sink. Dr. Patnaik never took the students to task for this. He would simply go to every table in the laboratory and coolly lift the filter paper from the sink and put it in the waste basket kept below. The teachers in charge of the laboratory classes would caution the students that Dr. Patnaik would come. That was sufficient warning for the students to keep their sinks clean.

Dr. Patnaik had an extremely good practical hand. His personal error level was very small. But he never insisted the students to work cautiously. He let them commit all the mistakes in the class so that they knew where they went wrong and how to cut down the errors. As much as he explained very concept in the theory class till the last student imbibed it, in the practical class he would like the student to repeat the experiment as many times as he may require to overcome his mistake.

After his return from Jeypore Dr. Patnaik was provided with a larger quarters on the campus. He was not married. Besides his parents, many of his nephews and nieces, particularly those studying in Ravenshaw stayed with him, including this author.

Out-house:

There was always a shortage in accommodation in the hostels of the college; the East and West Hostels could not cater to the requirement of rooms. The quarters allotted to Dr Patnaik was provided with a garage and an out house block of three rooms. Because of the shortage of hostel rooms, some students

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of the College were accommodated in these rooms, so much so that some three students opted to stay in the garage. As there was no window in the garage the wide front door was wide open, locked only when all the occupants were away. A part of the garage also served as their kitchen. Naturally on many occasions the inmates of the out-house block were invited to join the household for lunch and dinner.

Dr Patnaik had brought from England an umbrella made of parachute cloth which he used all the 365 days of the year. Every year before the onset or rains a particular cobbler would come to the house and repair it with care. He also used a pair of black Oxford shoes regularly. This too was given a yearly servicing by the same cobbler.

Much later in the year 1958 one of his nephews (the author herein) had taken admission in the East Hostel, sharing a room with some three or four others. When the Principal, Dr Sadashiv Mishra came for inspection found that one of the beds was unoccupied. On enquiry he found that the unoccupied seat was allotted to the nephew of Dr Patnaik. He cancelled the allotment, caught hold of the nephew and reprimanded him that the uncle spares his out-house block to students who could not get place in the hostel and the nephew blocks a place in the College hostel.

Save for a few occasions, all the students were needy. Batch after batch of needy students had stayed in these out-house rooms. In the college these students had a different status as occupants of Dr Patnaik's out-house.

The inmates of the out-house block completely vacated their rooms during the summer vacation when the marriage ceremony of Dr Patnaik's niece was to be organised in his house. They did, however, render their help in the marriage feast and participated therein.

They came back to their rooms soon after the marriage was over and resumed their studies, some for their supplementary university examination. Much much later when the next larger quarters, next to the existing accommodation, got free it was allotted to Dr Patnaik. With him and his family members, the then inmates of the out-house also moved the new quarters. Having stayed in those rooms for nearly four years some wished to stay back. But his successor in the previous quarters did not let them and they moved to the new accommodation.

Abiding to Rules:

One of his nephews, Nalinikanta Mohanty who had been staying with the uncle most of his student days, was then in State Government employment. He was posted at Cuttack but was not provided with any accommodation. Most of his life having spent with the uncle, he naturally came to occupy a part of the Ravenshaw quarters. As per the existing rule the uncle had to inform the Government of this, giving the details of the post he was holding. The nephew was asked by the government if the government accommodation in Ravenshaw College compound had been sublet to him, which was illegal. He was supposed to share a part of the rent. This rule of the Government so infuriated Dr Patnaik's sisters that they asked all their college going children to leave the uncle's house forthwith. But they continued to stay with the uncle.

In course of time elder brother, Harmohan moved over from Dhenkanal and joined the family in the Ravenshaw quarters.

Manmohan Mishra:

Shri Manmohan Mishra, the most constructive leader of the then Communist Party of India, staying at a stone's throw, became a regular visitor to the house. He intimately participated in the

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discussions not only in the political situation in the country but also in political philosophy as a whole. He was a good speaker and balanced thinker. The younger inmates enjoyed his company and always impressed upon him to join them for the repasts. Uncle Harmohan had a logic --- as. Smt Mishra was unable to participate either in our discussions or our lunch, since the discussions, being abstract, could not be physically moved, he used to fill his pockets with packets of some of the ingredients of the feast, like rice and vegetables while accompanying Manmohan Babu to his house.

When Biju Patnaik started his own newspaper, Kalinga, Shri Mishra was appointed the Editor. With all his sincere efforts it was by far the most readable daily journal in the state. He took the liberty of voicing many of the discussions in the house of Dr Patnaik in his editorials.

Culinary Exprtise:

Dr. Patnaik was extremely good at cooking. Although there was a cook and a servant, he cooked the curry while rice and dal etc., were prepared by the cook. The inmates really enjoyed the curry. No oil was used, only unadulterated pure cow ghee. Otherwise grated coconut was the source fat in the curry. Jokingly the nephews said that they had a Cambridge Ph. D. as their cook.

The young inmates took their breakfast by themselves. At lunch at 10 in the morning all the inmates including Dr. Patnaik had their lunch together. Each washed his own plates by himself. They also swept and swabbed their rooms and cleaned their dresses on their own. The house could easily be called an 'Ashram'.

When Dr. Patnaik returned from Cambridge he wanted to have meet both for lunch and dinner all the seven days of the week. But in course of time he turned completely vegetarian. Fish and meet were in fact totally prohibited from the house. He permitted his nephews to consume non-vegetarian food outside. One of the nephews who was extremely fond of hot and spicy non-vegetarian dishes was said to be the yardstick. If he opined that the curry cooked by the uncle was good then it was taken as really good.

As his research work progressed and he worked till late in the night in the laboratory the inmates had to make do with the curry cooked by the cook. But they all waited for the uncle to come back for dinning together.

Time to time some of Dr Patnaik's maternal uncles visited him and stayed in his house for long periods. They could not gulp their rice without a good coating of ghee. In spite of all efforts to procure pure ghee, often it was not possible to get. In the absence of ghee, they were game to do with 'Dalda' (hydrogenated groundnut oil). It was obviously extremely obnoxious. Dr. Patnaik devised a means to overcome this situation. He asked the cook to boil about fifty grams of Dalda and put some ten grams of zeera and give a 'baghar' to the dal and serve it piping hot to the 'mamas' and they appeared to take it with relish.

One one occasion 'puri' and curry prepared from gram daal, potato and red pumpkin had been brought from a nearby sweetmeat shop. The curry tasted very well to both Dr. Patnaik and brother, Harmohan. For several days thereafter the same curry was prepared till the young inmates got tired of it. One day one of the older nephews prepared the same curry but with plenty of ghee and spices. Both uncles partook plenty of it and got severely upset stomach. After that the impugned curry was discarded from the menu.

Several years after, only breakfast and lunch were prepared at home and taken together, but dinner was taken outside in a local restaurant, Cuttack Sweet Stall, where the cooking medium was ghee.

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And the standard menu was 'chapati' or 'kachori,' curry and milk, sometimes supplemented with 'rasagola.' The uncle used to leave the necessary amount of money for dinner bill.

Research and Publication:

Dr. Patnaik strongly patronised Indian scientific journals. His reasons were if all the good work was sent abroad how were our journals to improve in their content. When he got requests for copies of his Indian publications he often had to photocopy the reprints for the purpose. He also encourage his students and associates to send their research papers to the Indian journals. When in Cambridge he published his paper with Professor Norrish in Nature, the most respected scientific journal of the world. Working in Ravenshaw college with his student Balaram Sahoo he again published in Nature, more to demonstrate that quality research was also conducted under Indian conditions.

Besides Chemical Kinetics he started work on reactions on rare earth elements and nuclear metal compounds. He employed sunlight for preparation of UF_6. As the reaction vessels were kept in sunlight mostly in front of his room in the Department he cautioned people not to go near, lest they be affected by radiation. Some of his colleagues commented that while protecting others from possible radiation hazard he was exposing himself to it extensively.

As his food habits had gradually changed to very docile food for his evening refreshment he started taking sandwiches with cucumber and ripe banana stuffing.

Trespassing:

As his research progressed and a series of papers appeared in print a strange incident occurred. An unknown man in his early twenties broke into his laboratory by cutting a whole in the glass pane, as he displayed later, with the help of a broken piece of pebble. On enquiry he told the police that he was told there were many valuables like gold in that room. He, however, could not tell who told him so. He appeared too innocent and was let off. Since Dr. Patnaik was working on uranium his cabin was guarded at night for several months by police in plain dress, for it was assumed that some wanted steal his research work which was said to be of national importance.

As his research work picked up he worked till late. After completing the days work he used to come back home by the road instead through the college field. He observed that soft projectiles were being hurled at him. Some also hit him; he was not hurt as these were soft. Consequently some of his junior colleagues or research scholars accompanied him on his way back at night. On one occasion the projectile hit the escort after which these stopped. Perhaps the projectiles were meant to scare him for coming late after his research work.

With the attempted theft of the past, the incidence of the soft projectiles gathered added importance. Offer of police guard was viewed as drastic. But thereafter every night he was accompanied by two escorts for a long time. However, his associate in uranium research, Balaram Sahoo had not been targeted.

Dr Prasad and Dr Parija:

Professor Balabhadra Prasad left the DPI position on being appointed as Vice-Chancellor of Patna University, his Alma mater. He was often requested to come as examiner for M. Sc. practical and Ph. D. thesis viva-voce examinations. From their London University association, he did his Ph. D. while

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Professor B C Das did his B. A., he used to be personal guest of the latter. Besides, Das succeeded him both in his office as well as the quarters in Ravenshaw campus. On one occasion Professor Das was out of station when Dr Prasad came. One of the nephews of Dr. Patnaik received him at Cuttack station and told him he would have to be Dr. Patnaik's guest and the nephew would be in attendance. Dr. Prasad replied that he would be the guest of the young Patnaik.

On that occasion Dr P K Parija invited Dr Prasad for dinner. As the latter was Dr Patnaik's guest Dr Parija also invited Dr Patnaik. As getting one on telephone at Ravenshaw College in those days was well neigh impossible he wrote him a letter which he got delivered at the residence of Dr Patnaik which his mother received but forgot to make over to the son. As a result Dr Patnaik did not know and did not go. After Dr Prasad's return the unfortunate incidence came to light and Dr Patnaik personally apologised to Dr Parija. Dr Prasad told his host, the nephew, that the courtesy is when the guest is invited so also the host, but they did not reckon that the young Patnaik in reality was the real host.

A Professor of Andhra University, Waltair had come as external examiner for M. Sc. Project evaluation. He was accompanied by his wife. They were the guests of Dr Patnaik. The Professor could manage to partake of the food prepared by the cook, but it was absolutely unpalatable to the lady. So she offered to prepare a meal of South Indian delicacy. While all the inmates of the house ate with great relish, the cook, Dhirasen, took great fancy in the food and prepared similar dishes the next day to the great pleasure of the guests.

Rheo:

Once a nice looking pup strayed away and landed in the house. Naturally it was given some food and it stayed on in the house. Someone named it 'Rheo' meaning resistance. It had good sense of smell and could sense the master, Dr Patnaik's coming from a long distance. At the time when soft projectiles were being hurled at the master the dog used to go about a hundred metres to accompany him.

During summer vacations often the house was just bolted from inside; one door could be pushed a little to open the lower tower-bolt. Rheo was the sole inmate. The front-door neighbours used to feed him. Never was there any trespassing or theft. Sometimes some mendicants of Mahima Dharma stayed without disturbing anything inside. The common saying was ``Dr Patanik's house."

When the news vendor came in late the evening Rheo used to rush to the gate barking. The regular man knew Rheo and did not get scared, and used to open the gate and handover the paper to him. He used take the paper in his mouth and take it to the master. But if it were a new man and threw the paper in, Rheo often tore the paper into shreds. If any of the inmates called out to him he would faithfully bring the paper.

Mahiyashi Mahila:

Shri Debendra Satpathy and his more illustrious wife, Nandini were staying not far from Dr Patnaik's house. Because of Debendra's earlier association with the family, the wife-husband duo sometimes paid visits. Both became regular visitors as they were drawn in to the training in political philosophy. Nandini was the daughter of renowned author Kalindi Panigrahi and was an accomplished short story writer and poet in her own right. She was a student leader in her college days with a distinct leaning towards the left.

In course of time both became extremely intimate, as much as inmates of the household. While Dr Patnaik was highly skilled in cooking his brother Harmohan was his anti-thesis. He could and would put

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inch-long, raw plantains into the well made curry just before being removed from the stove. Nandini was very helpful in such occasions; she could stand up to Harmohan and prevent him from spoiling the curry.

During the discussions in social and political conditions in the country Nandini was not ashamed to ask any question, even the ones that turned out to be foolish when explained. She appeared to absorbs the utmost out of the discussions. Often there were difference of opinion on social issues and Nandini, after due deliberation would summarise all the factes and provide her considered opinion. Brother Harmohan was inclined to coin her as "Mahiyashi mahila." Time proved him correct. Biju Patnaik made her MP in the Upper House and she went on to become the Chief Minister of the State for many terms.

Public Service Commission:

As the only Professor in the Department of Chemistry Dr Patnaik was the only expert member in selection of faculty members in Chemistry by the Public Service Commission. When Dr M K Rout become Professor, in addition to Dr Patnaik he too was invited by the PSC. On one occasion the candidate who was a very poor in his studies, but rapped out answers immediately after the question was asked. But the answers were all wrong and had no relation to the question. So on the first day Dr. Patnaik gave him a zero in knowledge of subject. The PSC members said he answered well. But Dr. Patnaik insisted that the candidate had no knowledge of Chemistry. The PSC, however, asked the candidate to appear before it a second time when Dr. Raut was the expert, without letting Professor Patnaik know of such a decision. On the second occasion the candidate's performance was identical and was again awarded zero in subject knowledge.

The candidate spilled the bean and it was later known that he had appeared the PSC interview a second time. Both the Professors had a talk between themselves. Dr. Patnaik felt slighted and decided to boycott PSC invitation as expert member. Dr. Raut also decided similarly, for it could have happened with him too. When the PSC invitation came next time both of them declined; if the PSC did not have its trust on these professors they could invite experts from outside. The Chairman of the PSC relented and sent letters of apology to both.

Cantab Fellowmanship:

When Shri Y N Sukhtankar, a Cambridge Tripos, was the Governor of the State Dr. P K Parija, an M. Sc. from Cambridge was the Vice-Chancellor. It was proposed to hold a get together of all Cambridge scholars. As Kulapati K M Munshi was coming to Orissa it was decided to hold a garden party of all Cambridge dons with Dr. Munshi. As it turned out there were extremely few Cambridge alumni, all the faculty members who had been to England be invited.

By this time Dr. Patnaik had come in contact with Acharya Vinayak Narayan (Vinoba) Bhave and changed much in his persona. He had donated all his ties to his friends and junior colleagues, though he still had some suits. In order to attend the get-together he thought it proper to be properly attired. A tie of brand name Tootal was procured from the local market. Fortunately it matched to his suit and Dr. Patnaik of the old walked out in his age old bright Oxford shoes.

After a ceremonial introduction session as the party started Dr. Patnaik came to presence of Shrimati Lilavati Munshi. From the formal talk the topic somehow changed to Sarvoday and Bhoodan movement. Dr. Patnaik had have plenty of brain-storming sessions of discussion on the concept of Bhoodan and Sarvodaya movement. In the discussion with Shrimati Lilavati he pointed out the merits and shortcoming of concept and practice. Lilavati called her husband and the discussions went deep into the night on the movement in rebuilding of the nation. Naturally the Governor too was pulled in and every

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one's attention got riveted unto this. Dr. Munshi asked Dr. Patnaik to get involved in National policy formation. This, however, became an eye shore for others.

Some time after this there were invitations from some universities requesting Dr Patnaik to take over as Vice-Chancellor but Dr. Patnaik was not yet prepared for such responsibilities. Averse to further envy he did not let it it be known outside.

Nirakarpur College:

From the very beginning Orissa never had a single party Government in the state; it had always been in coalition with minor partners. For the first time Biju Patnaik led Congress in 1961 came out successful with over 80 out of the 140 Assembly seats, and became the Chief Minister. With the brute majority he started making sweeping changes towards progress in the State. One of the measures was higher education. He wanted many colleges. The then DPI made a statement that there were procedures for opening new colleges and schools to which Biju Patnaik reacted sharply that he would take over education in his own hands. Thereafter the DPI was ready to bend backwards to please him.

Dr. Patnaik as the Head of the Department, received a note from the Principal asking what glass-ware, equipment and chemicals the Department of Chemistry could spare for a new college at Nirakarpur, not far from Cuttack. He had a brief discussion with some of the faculty colleagues who opined that whatever has been procured were the requirement of the Department. He, therefore, replied accordingly.

Apparently the DPI had written to the Principal asking for a temporary loan of chemicals, glassware and equipment etc. to the said college for its formal inauguration by the Chief Minister. But nothing of this was mentioned in his letter neither was any mention made in the Principal's note. Not aware of such background Dr. Patnaik had, therefore, made a matter-of-fact response, witch in the normal course would have been forwarded to the DPI.

In continuation of the matter the order came from the DPI to suspend Dr. Patnaik and put the next senior most faculty member in charge and get necessary chemicals, glassware, etc. issued which were to be returned after the inauguration. This information probably leaked and came to be known outside, in Chhatra Bazaar, the wholesale vegetable market next door. The elder brother Harmohan per chance heard the threat by the traders of Chhatra Bazaar that they would not obey any discipline and enter the College if Dayanidhi Patnaik were suspended. He obviously was taken aback. He heard the murmur that for Biju Patnaik to inaugurate another college why was it necessary for Ravenshaw College to loan things?

The elder brother enquired from Dayanidhi about the matter and asked him to discuss the matter with the Principal who later explained the purpose. Necessary chemicals and hardware were issued on a temporary loan basis. The Department later offered that these could be retained by the college with the cost of the material transferred to Ravenshaw. The Department also offered to process the procurement for this college for a few years, if so desired, with corresponding book transfer. Thus an unnecessary, uncalled for and embarrassing situation was avoided.

Misappropriation of Rs. 37.50:

In the year 1962 Dr Patnaik was again the Head Examiner for M.Sc. Practical Examination after several years. Apparently, the practice in the meantime had been to manipulate the accounts so that there was no surplus left. That year after the examination, money was disbursed from the advance sent by the

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University on different heads as per the University norms. A surplus amount of Rs. 37.50 was left. Therefore, the unspent amount had to be refunded to the University and as per rules this had to be done through a treasury challan. Since the amount was too meagre and the process of obtaining a challan was rather cumbersome, Dr Patnaik as the Head Examiner decided to keep this amount in the Department to be utilised in the same examination in the subsequent year. The University was informed accordingly and said amount of Rs. 37.50 was kept in an envelope along with a copy of the said letter in the Head's cupboard. In response to the said letter, the University, while sanctioning advance for the subsequent year (1963) M. Sc. Practical Examination mentioned that the residual amount of Rs. 37.50 was available with the Department which can be spent along with the fresh advance money.

A few months after there was 'raid' by the Crime Branch at the Department Office and residence of Professor D Patnaik on the allegation that Professor Patnaik had misappropriated government money. Interestingly the investigation by the Crime Branch was ordered by the then Deputy Chief Minister, Shri Biren Mitra, who also was the Home Minister, was a classmate of Dr Patnaik in PM Academy, Cuttack.

Crime Branch sleuths coming to Ravenshaw College created a great turmoil and the greatest humiliation that could be perpetrated on Dr Patnaik, the epitome of honesty, that again for an honest piece of work. It was obvious that the informer to the Crime Branch had to be an insider, one in close confidence to the said examination, for this could not have been known to any outsiders.

This was indeed the last straw on the camel's back. It is possible that this might have triggered all the sad memories of the past harassments and humiliations mated out to Dr Patnaik including the allegations of misappropriation in Vikram Dev College and threat of suspension for Nirakarpur College and all that.

The above incident broke him apart and consequently, Dr Patnaik's life took a turn in different direction. No wonder he decided to part with the educational system and said goodbye to Ravenshaw College for ever.

Just as he was leaving he received letter of appointment as Vice-Chancellor of the then University at Sagar in Madya Pradesh. He did not feel obliged even to reply that he was not interested. After his departure, offers from many other Universities did come. When there were no response from Dr Patnaik, queries were sent to the Principal of Ravenshaw College. The Principal had naturally responded that Dr Patnaik's whereabouts were not known, as he had not left any address for communication.

Joining Sarvodaya:

Dr Patnaik's life indeed took a big turn around. After leaving Ravenshaw he made a few visit to those he revered, his eldest brother, etc., before proceeding to Wardha to meet Acharya Vonoba Bhave. It may be recalled that Vinobaji on his earlier visit to Odisha had stayed with Dr Patnaik when he had detailed discussions with him on the phylosophy behind Bhoodan and Sarvodaya Movements and possible fitfalls in their implementation. At that time Dayanidhi had written poems in Odia in praise of Vinobaji.

While with Vinobaji in 1963, Dr Patnaik fell seriously ill and had too be hospitalised. The Civil Surgeon of Wardha wrote to his elder brother, Doctor Satchidanand Patnaik giving all details of his ailment and treatment. He kept Doctor Patnaik informed of the prognosis till he got cured and left the hospital. There after there was hardly any news about him.

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Apparently he was detailed to Haryana for interaction with the farmers and peasants. He spent a fair length of time and was deeply involved with the peasants and workers of the state in their peaceful growth and development instead of their inherent militant attitude. He also organised them to channel government development programmes of subsidies and agricultural loans to their best benefit. He had come to be popularly known as {\it Haryana Gandhi.}

During 1976-77 Loknayak Jayprakash Narayan (JP) gave his call for open revolt by the Defence forces against the Indira Gandhi Government which created an unforeseen situation. Shrimati Gandhi sought Vinobaji's advice; the latter asked Dr Patnaik to meet her. He was then in Chandigarh. Therefore, he came to Delhi time and again to meet the PM for discussions in this regard. Even glimpses of these discussion never came to light, save for the open secret that he had met the PM.

By this time his food habit had undergone a sea-change. He used to cook his only meal of the day in the evening in his own pressure cooker which he carried with him. He excused himself from the lavish State dinners and cooked his own himself.

Homoeopathy:

In the meantime Dr Patnaik had made a rigourous study of Homoeopathy on his own to add to his own knowledge of Chemistry and dispensed medicines to patients, particularly his colleagues and co-workers. A patient in Bombay had multiple nodules on her veins which could not be cured by alopathic doctors. He gave her some eight different medicines to be taken in a very unique way -- 1 to 5 after breakfast, 2 to 6 after lunch, 3 to 7 after dinner and 4 to 8 next day after breakfast, in this rolling fashion. Her veins had become normal before the stock of medicine was over.

Dr Patnaik gave his nephew's wife (wife of the author herein) a copy of a small book published in English language by a German publisher covering the treatment of some common ailments by some simple medicines for her to practice this system of medicine --- a novice's Homoeopathic treatment. The pamphlet was pilfered from her bookshelf.

Years in UP and MP:

At the behest of Vinoba-ji he went to UP and MP and spent many years in various places like Mainpur, Betul etc. Many of them have Ashrams named after him. One of these had a very small compound. One of his nephews was the Commissioner of the Division who sanctioned some Government land so that the Ashram could expand its activities, particularly in the aid of the women of the area.

Cow Slaughter Ban:

By 1980-81 it was observed that young, healthy cows, after giving birth one or two times were being slaughtered for consuming beef. This was not considered a welcome move.

There was a strong movement to stop cow slaughter. Sensing possible escalation of this to uncontrolled dimensions, Vinoba ji asked a group of workers, under the leadership of Dr Patnaik, to conduct the movement peacefully. About two hundred Sarvodaya workers gathered in Bombay Congress Bhavan. Several meetings were held to plan the course action. As usual the participants had all very hazy ideas as how to go about it. Dr Patnaik would let super enthusiasts to preside over the session and let all and sundry to express their opinion on the matter. When they would all be confused over the matter Dr Patnaik would sum up beginning with 'Bhai ka yeh kahn hai ki $\ldots \ldots$' and put his ideas cogently and coherently. And all would agree with an emphatic "Haan."

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By this time animal slaughter had been well organised in the Deonar Abattoir. The agitators used to picket at the gates and are arrested by the police to be released by lunch time -- a very peaceful but a strong reprimand. By this time elder brother Harmohan also had reported for 'Satyagraha.' The owners of the Sarvodaya Hospital in Ghatkopar in Bombay provided accommodation and served very pious food for the participants. This peaceful movement went on for several days till the Government relented.

Family Time:

During this visit to Bombay Dr Patnaik and brother Harmohan visited the two cousins, this author and brother Harmohan's son, Pranab. Both brothers were highly pleased at the opinion of the Bajaj higher-ups that Pranab, then a manager of bank was scrupulously honest. Both brother visited the cousins at home and were pleased with their families.

Dr Patnaik was happy to be back with family after the lapse of nearly two decades. Though he was good at cooking in his days he had forgotten the nuances of making 'chakuli' (equivalent of 'dosa'). The elder brother explained the prior preparation was required for its making. To the great pleasure of both brothers the two daughters-in-law prepared 'rawa dosa' which both partook with relish.

At IIT-Bombay Dr Patnaik met his earlier student Dr B K Sabat who had lost most of his hair from his scalp. Dr Patnaik was so pained to see this. At his age he had not lost much of his hair nor had his hair turned grey. He had the same thick scalp-ful of steel-grey hair on his own head at the time of his demise.

His Return:

After two decades and two years, two weeks and two days, Dr Patnaik returned to the state. He first went to Puri for a 'darshan' of Lord Jagannath. Brother Harmohan quipped that Ramachandra went on ``Van vash" for fourteen years whereas Dayanidhi returned after 22 years. Then proceeded to Dhenkanal to his ancestral home. By that time the house had been in pretty bad shape. The room in which was born was no more habitable. What was the granary in his time, where he had left eight tonnes of paddy while proceeding to Cambridge, had been made into a habitable room and he occupied the same.

His food habit having changed he lived on milk, fruits and some 'mudhi' and peanuts in the day and had one meal in the evening comprising of couple of 'chapatis' and boiled vegetables which he himself cooked. Cousin Prasanna 's wife, Sakuntala made the chapatis for him everyday.

Many of the family members, friends and acquaintances visited him at Dhenkanal. Recalling his fondness for it, they brought fruits for him. He appeared to have comfortably settled down there. If anyone wanted him to come anywhere he used to say just wait for mere three months and then I shall accompany you anywhere. On hind thought one could say he had the premonition that he would not be there after three months.

After settling down he started his practice of homoeopathy. He obtained a huge quantity of sugar globules of different sizes and homoeopathic medicines of different potency and gave the required medicines free of cost. He particularly attended to the poor and leprosy patients. Every Sunday he fed some patients his own diet of 'mudhi' and peanuts.

In spite of not being mentioned any where and ignored everywhere, Harmohan Patnaik always drew a crowd whenever and wherever he was present. With Dr Dayanidhi Patnaik in tandem there were a congregation of people all the time in the humble abode of Dr Patnaik. In the morning around ten and in

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the evening at six there was an audience for Dr Patnaik, at least his cousins and nephews were in attendance. The discussions were worth listening to, both informative and thought provoking.

This continued for about two months. That he has settled down at Dhenkanal was reason enough for this author to come from Bombay to meet him there. Arriving early morning of November 10 he spent the whole of the day with the uncle. Apparently that day itself he had been unwell with a

mild fever. The ailment aggravated the next day as if he had been waiting for this particular nephew. Thereafter, he was bed-ridden. The lunch the nephew had with him was his last lunch. As if he had his premonition he had written to the nephew to Bombay sometime after coming to Dhenkanal that he should light his pyre and underlined the line in red.

A few days after he was shifted to the District Head Quarters Hospital. His brother and sister-in-law came down from Bhubaneswar and were with him in Dhenkanal. When it became apparent that he may not improve any more it was decided to inform the two other nephews, this author and brother Harmohan's second son. A phonogram was never sent to the author. Thus he could not be present for the funeral, notwithstanding Dr Patnaik's desire for the author herein to light his funeral pyre. The family members of an Odia research scholar, reading in the newspaper about the sad demise informed and the author rushed to Dhenkanal only to take part in the last rites.

The last moments of his life he was reciting the ``Vishnu Sahashra Nama" and ended up with his favourite hymn, ``Hey jagatrata ....." He breathed his last on the ``Shiva Churtdasi" Bada Osha day on November 26, 1985 just after completing 67 years of age.

A controversy arose as to should he be given a burial, for in real sense he ad become a 'rishi' in real sense. Extended family members prevailed that he be cremated and he was, leaving behind a very adoring family.

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A Tribute to a Great Professor

Shri Bhaskar Chandra Dash

A mind overcast with rural centric anxiety and the antenna of perception highly vulnerable at that teen age of sixteen plus, I was really proud of being a Ravenshavian enrolled as a Pre – University student of science class in 1959-60. Ravenshaw College, the premier and most glorious bustling hub of Odisha which had groomed the career and lives of large number of students as a passport to their academic prosperity had roped in talented intellectuals like Late Dr. Sadasiva Mishra, Professor of Economics and the then Principal, Late Dr. Bansidhar Samantaroy, Professor of Botany, Late Dr. Brahamananda Mishra, Professor of Physics , Late Dr. Dayanidhi Pattnayak, Professor of Chemistry among many other luminaries whose versatility and multi-dimensional fecundity have immortalized them. If they have left their foot-prints on the sands of time, that is not by simply sitting down. They stood for values in their moral splendour unwilling to dip their hands in dirt or soil their lips with spite.

On this memorable occasion of celebration of the birth-centenary of Dr. Dayanidhi Pattnayak, who was one among the cluster of erstwhile distinguished Professors, I deem it a rare privilege to lay down some splendid experiences churned out of my studentship. Of Course, I humbly confess that my yardstick is too small to fathom the depth and profundity of knowledge with which Dr. Pattnayak was equipped. In this context, I am inclined to quote the illustrious English Poet T.S.Eliot " Only those who will risk going too far, can possibly find out how far one can go".

A brilliant academician, an excellent teacher and an inspiring Guide Dr. Pattanayak was an epitome of courage and dedication . He led a very simple and austere life because he believed that life should be lived in pursuit of excellence even in the midst of difficult situations and struggle for existence. His face mirrored his feelings and emotions, he could not be diplomatic in concealing his feelings. He never projected himself as a pedantic teacher or a heavy –loaded moralist. We have often pleasantly noticed a persuasive touch in his remarks and lectures. I recollect that in course of his early lectures in the class once he said , " Not every one can be an inventor, a creator or discoverer, but every one has the ability to see things differently. Like a genuine teacher, he had the potential to draw the creativity out of the taught and aid them to explore some of their potential. A teacher's life should be a living testimony to the teaching he wants to communicate – Prof. Pattanayak was a glaring example.

Later in 1961 we were made to understand that urged by his patriotic fervour Dr. Pattnayak had quit his Professor's job and associated himself with Vinoba Bhave's Bhoodan Movement. Mahatma Gandhi said " Be the change you want to see in the world. You have to fall in love with what you do, everything else becomes easy. " That waggery of fate which started clive as a writing clerk, Gray as a Linen-draper, Keats as a surgeon, Shakespeare as a theatre – boy and a thousand others in a thousand other odd ways rolled and diverted Dr. Pattnayak's life towards a different destination though emboldened by his determination to do something for the society, the world and make his existence a positive element with a new joy.

Dr. Pattanayak's students are still unabashed in their affection, appreciation and applause for their esteemed teacher. One such student is the Octogenarian Dr. Balaram Sahoo, former Professor of IIT, Kharagpur, a native of Gopapur under Baramba Tehasil in the district of Cuttack. He was one of his

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indulged favourities. Prof. Sahoo and myself belong to the same nativity and I was fortunate enough to be his student when he was a lecturer in the Ravenshaw college prior to his joining the IIT , Kharagpur. Prof. Sahoo has taken every experience in life as part of a learning or growing process. He grew among men who made history and eventually he made history in exploring new horizons in the domain of Chemistry. As a true disciple of Dr. Pattnayak, he believed in the concept that progress is directly proportional to persistent effort. As a matter of fact research Scholars have found in him a very good guide and thirty seven such scholars have earned Phd under his guidance.

After his superannuation, Prof. Sahoo has chosen his native place as his peaceful abode preferably because no other location would provide him that feeling of belonging, that identification as his sweet home and innocent native people would render. He spends his time teaching students at the local schools, writing books on science subjects, reading voraciously on varied subjects and has thus kept himself intellectually busy and active at his eighty Seventh year of life.

When people become inquisitive enough to know from Prof. Sahoo about the long journey of his active life, he unhesitatingly replies that clarity of intention creates stability of mind. He very often makes reference to the life – style and ideology of his revered teacher Dr. Pattnayak in this regard. Often when people have sublime experiences, such experiences soon become inspiring memories.

When I humbly pay my glorious tribute to my former teacher Late Prof. (Dr.) Dayanidhi Pattnayak, I feel that my memory really inspires me with the experiences I had with him although for a very brief period of time.

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In Memory of Dr. Dayanidhi Patnaik

Dr. Duryodhan Mangaraj

Dr. Dayanidhi Patnaik was my teacher and guide during my B.Sc. and M.Sc. studies at Ravenshaw College. He was a very learned person, and had a PhD. degree from Cambridge University. I am personally grateful to him for shaping my career. When all my classmates were applying for government sponsored foreign studies, I was keeping away from it, because they were senior to me by one year. I was carrying out my research work at the laboratory under the guidance of Dr. Sukumar Aditya. One day he came out of his office and asked, Duryodhan, why are you not applying. I told him that my colleagues, who are senior to me are applying. I do not have a chance. He told me that "Are you Brahma. Do you know everything? You better try, before giving up hope." I was surprised, but listened to him.

I went to the college office and filled up the application form. I did not have a chance to think about the subject of my study. I ran to the library and saw a series of books on High Polymers. I came back and mentioned in my application that I want to do Ph.D. in High Polymers. Dr. Patnayak thought that it was a good selection and recommended my application. To my utter surprise, two months later I got the information that I was selected. That little encouragement shaped my career. I am very grateful to him for his kind help.

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Dr. Dayanidhi Patnaik: My Teacher and a True *Sanyasi*

Dr. Indu Bhusan Mishra

I was a student of Dr.Dayanidhi Patnaik. I did my Master's in 1959, published two papers with Dr. Patnaik and was initiated to the world of research which is still active in me in 2018.After my Master's degree I joined Ravenshaw College as a lecturer and continued my research under Dr. Patnaik's guidance towards a doctoral degree. But things changed very soon.

Dr. Patnaik, then the only Professor and Head of the Department, resigned his job and sacrificed everything and became a true *Sanyasi* with Acharya Vinoba Bave as his *Guru.* At first we were skeptical. He who got his Ph.D. working on "Fast Reaction Kinetics by Flash Photolysis," from the world renouned professor RGW Norrish of Cambridge University, would just quit like a flash was incredible for our understanding. We also knew that Dr. Patnaik first started his research with Dr. EA Moelwyn-Hughes an expert in solution kinetics, nick named "Hinselwood in solution." At a departmental party at Cambridge, Dr. Patnaik danced with Norrish's daughter and requested if he could switch to her father for work on the frontier research of the time. She introduced her date for the evening to her dad and rest was history. You probably all know that Norrish and his student George Porter of Columbia shared the Nobel Prize in Chemistry in 1967 with Manfred Eigen from Max Plank Institute. I was fortunate to learn fast photochemical gas reaction kinetics from Dr. Patnaik and later "damn" fast reaction kinetics in enzyme reactions in graduate school at Southern California from one of Dr. Eigen's students, Dr. Fred Schneider in 1967!

But his decision was firm and final. I remember, I went to Angul to his home, where he was briefly there before joining Bhoodan. He had disposed off all his belongings and had a Rolex watch, which he needed help to get rid of. My effort to persuade to return to Ravenshaw was of no avail. Instead he advised me to seek higher degree outside of India which I did a couple years later in 1966. He fed me what he cooked – in a big 'vat', rice, dal, mixed vegetables and spinach with a little ghee all mixed together, which of course I enjoyed immensely.

Dr. Patnaik was a great teacher, ney an inspiring teacher. I was one of his naughty students, yet liked by him. I got two papers published with Dr. Patnaik and I distinctly remember his caution to me. "When you publish, you tell the whole world you have something new. The work must be reproducible." For my first paper, a novel analytic technique, I repeated the analysis 24 times! Later in my career I realized the importance of his training, although I got bored with the task of repeated testing then. He was preparing my mind to always focus on reliability and reproducibility

After being with the Acharya for a few years, he gladly accepted his Guru's command and worked at a school for small children. He lived in a small hut, content with what he had, cooked his own meals, washed his own clothes, and taught these children character building as well as academic subjects. We always called it a waste in his education. But he was self-actualized and his action was similar to Paramahansa Yoganandaas he followed his Guru Yucteswara's command and opened the first Yogada school in Ranchi.

Fifty eight years after I parted with my teacher and reverend Guru Dr. Dayanidhi Patnaik, I prostate before him and chant:

Guru mat pita, guru bandhusakha
Terecharano me swami mere koti Pranam

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Down the Memory Lane

Prof. Prabhat Kumar Misra

Dr. Dayanidhi Patnaik having passed M.Sc from Patna University in the year 1941 joined in the Department of Chemistry Ravenshaw College, Cuttack as a Member of the Faculty. In the year 1947, he want to Cambridge University for his PhD and on return joined Ravenshaw College again. I was a student of Ravenshaw College from 1951 to 1957. In addition to study, I had a lot of interest in sports and games and represented the college in many events.

One day, when I was in the hockey field, one Professor came with a typical English Blue Stripe Suit, took off his Coat and entered the field with a hockey stick. Earlier to that, old retired Prof. Narayan Mishra was playing with us. But Dr. Patnaik fresh from Cambridge played. We learnt that he was a Patna University Blue in hockey. He used to regularly come after the class and taught us lot of tricks of the game. One day he wanted to teach how to take a hit properly. We all surrounded him. He placed the ball & raised his stick towards the back which hit Dillip Babu a senior & he was bleedings. Dr Patnaik was very much worried, immediately sent a boy to get a rickshaw and took him to hospital and saw himself the treatment. Dr. Patnaik was in-charge of games and took keen interest in all sports and games.

Another incident, he was taking Honours Class and teaching chemical kinetics. At the end he asked us to solve about 10 problems of first and second order reaction as homework. In the next class, he asked everybody individually. Most gave false answers as to why they have not, even few spoke lies. The last one was Chanakya Misra. He asked Misra ...why? Chanakya got up and said Sir, the sums were too easy to be worked out. Dr. Patnaik immediately said Misra, do not take life so easily from now. You have years to face etc.etc.

He had a unique method of teaching. He would be repeating the same sentence time & again so that he wants to make it sure that each student of the class room completely understood what he teaches. His classic class was on Avogadro's Number.

Towards the mid fifties, he had stopped going to hockey field, Khadarh has taken over the Blue English Suit.

We were neighbor in the college quarters. Santanu Acharya and Pareswar Jena were staying in his out house and Bhramarabara Jena and Dinabandhu Misra were staying in our out house. That was the pattern then.

We were only seven students in the M.Sc (Chemistry) class. About ½ hour before the end of the practical class, Dr. Patnaik used to leave the class, go to his room & then take walk in the department quadrangle with Balaram Babu. We just could not leave until he came to the class then ask Giridhari, the attendant, to get some tiffin for all of us, then discuss about the experiment. On those days, the college had a match either football or hockey. I was in great trouble. I used to go to Dr. Sukumar Aditya, take his permission & leave for the games. Next day in the theory class, Dt. Patnaik said "there are only seven hockey students who have got the opportunity to read M.Sc, but only one of them goes to play. His

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classmate Prof. Raj Kishore Misra often comes to lab and says, Dr. Patnaik why are you keeping the students so late?

All of a sudden Dr. Patnaik left Ravenshaw College in 1963. We learnt that, he joined Sarvodaya Movement of Acharya Vinoba Bhabe. Dr. S.K. Mukherjee, the then Vice- Chancellor of Burdwan University, West Bengal used to come to Ravenshaw College as External Examiner. He was together with Dr. Patnaik in Cambridge. Knowing that Dr. Patnaik had joined Bhoodan Movement he remarked that Dr. Patnaik was not coming back. He said, once Dr. Patnaik takes a decision he follows it sincerely & sticks to it. Giving an example he said while in Cambridge some asked him as to why he does not dance. In a few days Patnaik took to the floor and was one of the best in Cambridge.

Dr. Patnaik was a great human being. Dedication, sincerity was his motto. After long years in Sarvodaya Movement, he returned back to Odisha & few days after that he breathed his last.

My respectful homage to the great teacher, my teacher and of many more, whom he made to stand up to his ideals.

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Dr. Dayandhi Pattnaik - A Rare Personality

Prof. Gopabandhu Behera

I entered Ravenshaw College in 1958 as a student of B.Sc offering honors in Chemistry. Chemistry was my favorite subject since I. Sc and I had almost decided to become a lecturer in Chemistry. The department was so big that initially I lost track but gradually I adjusted myself to the new surroundings with many close friends. I was staying in the East Hostel with a window seat in room no 21. After about a fortnight or so I came to know that Dr.DayanidhiPattnaik was the Head of the department. His sitting room was in the arm of the department facing the grass quadrangle of the college. He had obtained Ph.D from Cambridge, an honorable feat at that time. Therefore I had a desire to see him as to how a Cambridge return would look like. But lo and behold! When I saw him for the first time in the corridors and my friend told me his name I was crestfallen. A Cambridge returned Ph.D holder of that time wearing very ordinary dress instead of a three piece suit, shining shoes, talking English and all those chacteristics of a western educated professor.

As my feet got strongly embedded in the corridors of Ravenshaw, I came to know more about him. He was working for Ph.Din the same room as Prof. Porter, who subsequently received Nobel Prize. Subsequently I heard that he was initially a very well-dressed person with western deportment. Dr. Balabhadra Prasad, an eminent Chemist of the country, who subsequently became Vice-Chancellor of Allahabad and Patna Universities, was the Head at that time. After he became the D.P.I. the responsibility fell upon Dr.Pattnaik, who was a reader at that time to manage the department. For reasons best known to him, he was attracted to Bhoodan movement, an idea started by Acharya Binoba Bhabhe. Dr. Pattnaik had completely changed his life style in dress, food, behavior etc. The most attractive part of his life was his honesty, integrity and a single personality. I started liking him. During that time meeting the Head of the department or a Principal was a very difficult task. So personally I had no contact with him in my third year honors class. Our physical Chemistry was taught by Dr. S. Aditya, late Dr B.Nayak,.Dr. D. Mangaraj, and later Dr. R.C.Das and late P.B.Das. Dr. Pattnaik was taking classes in I.Sc. and M.Sc. Occasionally he would drop in to the Honors class if some teacher would be absent that day. He was giving us a good bath with several questions of fundamental nature.

I came in close contact with him during my sixth year class. We were nine students(five of us namely Parvati, Durga, Nimai, Purna and Biren have already passed away) in M.Sc and our classes were taken in the Physical Chemistry lab. There was a big volume of Physical Chemistry book by S.Glasstone and the book became a bible for us. We used to keep the book below the desk and bring it out when he would enter the class.He was absolutely time bound to take a class and usually was taking two periods at a time. His fundamentals were very strong and had a very clear vision. Intricate problems wereexplained with simple examples. He was in fact an excellent teacher. It is difficult to forget his manner of teaching. My interest in Physical Chemistry grew and I became more and more confident in problem solving and derivingequations. The Sixth year was devoted to physical chemistry practical and research work. Dr. Pattnaik would visit the laboratory almost every day at about 5pm and take stock ofour performance. He would clarifythe reasons of our failures and doubts with ease.

After returning from Cambridge, Dr. Pattnaik perhaps wanted to start work in kinetics of fast reactions and therefore had installed a liquid air plant. But he diverted to Uranium Chemistry for reasons

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best known to him. The liquid air plant remained untouched in Bhima's (mechanic) room for decades. During our fifth year we would observe solutions in conical flask getting exposed to sunlight and some precipitates coming out. Later we knew that it was photochemical precipitation of UO2. He was perhaps the first person in India to photo chemically precipitate UO2.His work on Uranium Chemistry got recognition from the country. During sixth year the students usually are offered thesis according to their choice. Though I had desired to be in Organic special and carry out my thesis in Organic Chemistry under the guidance of Dr. Rout, I was given physical Chemistry as special and a research problem under Dr.Pattnaik. Myself and Late NimaiNaik were asked to work together. I carried out the work for a month sincerely and learnt the technique of exchange process. Later I shifted to Organic special and worked on oil chemistry The oil was extracted from GarciniaXanthochymus and CaesapiniaBonducella and the composition studied by urea adduct method since GLC was not easily available then. He became a Professor perhaps in 59-60(if I remember correctly).

Dr. Pattnaik became very much engrossed in Bhoodan Movement and later left the job to become a whole time worker in answer to the dictates of his conscience. He was a bachelor and had no obligations. Such a decision can be taken by a person of strong determination and a strong desire to adhere to an ideal. He has left a mark in the corridors of Ravenshaw College and the centenary celebration shall be able to inject his ideal, dedicated life to the young students.

Dr. Dayanaidhi Pattnaik breathed his last in Punjab, where he was fully engrossed in Bhoodan movement. I take this opportunity of paying my respect to the ideal soul who has inspired me to be a teacher and a researcher. I also congratulate those who thought of celebrating the birth centenary of my erstwhile Professor, whom I admire till today.

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Beeps of Reminiscence

Prof. Anadi Charan Dash

As days rolled on many happenings in my academic life in the past remained buried in oblivion. But a few of these carved indelible impressions *in my memory channel.* Some of these relate to my revered teacher, Professor Dr. Dayanidhi Patnaik. I feel honoured for getting a chance to pen down a bit of those remembrances on his centenary year of celebration.

July 1958, I was a first year I. Sc. student in Ravenshaw College. Professor Dr. D. Patnaik used to teach us basic Chemistry. The CLT1 was the place where all my batch mates assembled right in time to attend his lecture and demonstration. The black board is set well cleaned, the bundle of chalks and duster are placed at the proper place by *Braja* the attendant at least half an hour before the class begins. Sir (Dr. D. Patnaik) steps into the lecture theatre right in time. In those days the students used to move in rapid stride from the PLT1 to CLT1 and vice versa across the old *Kanika* library in order to secure a seat as close to the teacher as possible. I was one of those 128 batch mates in that competition. Sir used to teach us, the new comers, the basics of Chemistry in a reasonably high pitch, rambling on the floor of CLT1 with the intention (I guess) that no one of 128 students in the class will fail to understand the essence of his lecture. His method of introducing elements, compounds, atoms, molecules, atomic weight, molecular weight, Avogadro number(N), principles of chemical combination etc. has left indelible impressions on me. He used to stress on the reasons for the dimensionless and fractional values of atomic and molecular weights of elements and compounds looking at the Periodic Table hanging on the wall of the class room. The huge and unimaginable value of Avogadro Number $N = 6.023 \times 10^{23}$ is unravelled when he jumps up in the class explaining that this is the number of water molecules present in merely 18g of liquid water and the number remains essentially invariant with respect to the physical conditions of water. The concept of 'mole' and its relation with 'N' as he used to decipher is indeed lucid and unique.

In one class Sir put some iron filings in a hard glass test tube, added some sulphur powder, mixed it uniformly by shaking and asked us: "do you find any change?" Then asked Braja to enkindle the Bunsen burner. He himself heated the test tube containing the mixture in the non luminous flame for some time and asked us to watch the change, then cooled in air and added some dilute HCl when rotten egg smelling gas could immediately be inhaled by any one of us in the class even sitting at the farthest corner of the room. That was his method of teaching Chemical Combination/ reaction and gaseous diffusion.

In another class he used to unbuckle his wrist watch and say "my watch only records time ". He then targets some one in the class, wearing a wrist watch which records time with emission of light from the spotted dial. By this he used to introduce the concept of the interaction of radiation with matter (a topic of his interest which fetched him a Ph. D. degree from the Cambridge University ,U.K., working in the research group of Professor R. G. W. Norris ,N. L). He used to say " Sukumar will demonstrate and explain the instability (radioactivity) of certain atomic nuclei in the class later". Next in one class Dr Sukumar Aditya, then a lecturer in chemistry in the the Department used to demonstrate that using a sample and a measuring equipment (I did not know then what these were). Recently I read an article in *Nature* which emphasized: "Science should be **SHOW ME** not **TRUST ME**" (No reproducibility without preproducibility, Philip B. Stark, *Nature*, **vol 557**, 613, 2018). Interestingly this was practiced long ago in the Ravenshaw college (chemistry Department) in the class room lectures for the beginners. Professor Patnaik was not

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only very agile in the class room, but more so while invigilating in the examination Hall in spite of his busy academic and administrative schedule even when he was the Head of the department.

In 1960, I was a B. Sc. (Hons) student in the Chemistry Department. Professor Patnaik taught us Physical Chemistry, the basics of Chemical Kinetics in particular. All his lectures were vibrant with concepts and ideas. He used to explain the distinction between order and molecularity of a reaction giving examples which had everlasting impression. On one occasion he came to the class with a bundle of answer books from the last examination. He showed me my answer book and commented "you have answered the question on Chemical Kinetics so well, but your handwriting needs considerable improvement". There was no anger on his face but sympathy, consolation and advice for a better future.

In our days, no class (theory or practical) was dropped in the Chemistry Department. On one occasion Professor Patnaik and one of his colleagues (I forget the name) were the teachers in charge for our Inorganic Chemistry practical. Both of them never sat till the completion of the class. They used to move from one student to the other inquiring about the experiment and watching us perform. I wish this practice continues in the Department to-day.

I was a boarder in the East hostel and allotted a single room in the first floor on the north block during my graduation period. One fine morning around 9 a.m. (time may not be precise) when I came to the corridor of my room, I noticed some persons in khaki dress standing in front of the sitting room of Professor Patnaik adjoining CLT1. It appeared strange to me as that was not the time for Professor Patnaik to be present in his room. From that time onwards I did not see Professor Patnaik in the Department, although he was present in his quarters in the campus. The Department of Chemistry lost a great teacher forever. He got involved in the Bhudan Movement lead by Acharya Vinoba Bhave and spent the rest part of his life as a social worker.

I was not aware of his research work during my early student days. But at a later stage I have seen (late) Dr. Nimai Charan Naik, associate of Professor Patnaik, experimenting on the sunlight driven reduction of U(VI) to U(IV). Another piece of research on chemical kinetics published by him from this institution is the instantaneous reaction of Fe^{3+}(aq) with $S_2O_3^{2-}$ resulting in $Fe(S_2O_3)^{+}$(aq) (a red coloured species) which decayed slowly to the almost colourless end products , Fe^{2+}(aq) and $S_4O_6^{2-}$ (G. Mahapatra, C. Nanda and D. Patnaik, *J. Indian Chem. Soc.*, **34**, 457, 1957). I came across this work when I was working on the ligand mediated stabilization of Fe^{3+}(aq) towards reducing agents like $S_2O_3^{2-}$ etc. Besides he authored (co-authored) several research papers in highly cited journals, one such being *Nature*.

I learnt that he was fondly addressed by his research colleagues in Cambridge (U. K.) as PAT. But the name "Dayanidhi" given by his parents proved to be befitting the most. He as a teacher loved students, was kind hearted, humane and compassionate but quite stern in attitude in the class room. In Chemical terminology he was like "Liquid Crystal"- having the quality of a liquid and as hard as a crystal. Generations of students will eagerly wait to have a "GURU" of his calibre. I pay my respectful homage to this great soul on the occasion of his Centenary celebration.

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The Testimonial I Cherished Most

Dr. Pradipta Kumar Jesthi

It was 1957. I had to take most important decision of my life regarding my career, whether to go for general line or to opt for technical discipline. For choosing technical line, I had to go outside Cuttack leaving our home which my parents did not want. The only technical college of our State at that time was University College of Engineering, Burla. It was two day's journey from Cuttack by train to Meramundali and then by Bus to Sambalpur and then to Burla. During that time, fortunately I got a seat in Post Graduate Department of Chemistry, Ravenshaw College, Cuttack. My parents were very much happy to hear that news. I had to accept that offer, as I had no other choice.

Ravenshaw College was my college where I was a student for last four years of my student life. After admission, I had taken my studies very seriously and put my sincere efforts. I decided to appear in PG Part- 1 examination positively which was not compulsory. During that period, I had the bad luck to have a severe attack of flue. In that condition, I took the examination and was not very happy about it. But I was surprised to see the marks which were beyond my expectations.

In the M.Sc 6th year, we had to take a thesis paper, either Physical Chemistry or Organic Chemistry. Dr. Dayanidhi Patnaik, then Head of the Department of Chemistry, was teaching Physical Chemistry. Dr. Mahendra Kumar Rout, Reader in Chemistry was the next man teaching Organic Chemistry. With my marks in Part-1 examination, I could have easily got Physical Chemistry as thesis paper. However, I liked Organic Chemistry very much and wanted to take that as my thesis paper. My friends insisted me to take Physical Chemistry as thesis paper, as then I would be a direct student of Dr. Patnaik, then HOD Chemistry. My friends persuaded me that I would have a better chance of securing good marks in the 6th year as all the papers were directly under Dr. Patnaik. We had an interview with the HOD Chemistry to give our choice regarding the thesis paper. In that interview, I took my choice to take Organic Chemistry because I liked the subject very much.

In those days, total numbers of seats in M.Sc (Chemistry) were only eight and that too only in the Ravenshaw College, Cuttack. Except Ravenshaw College, nowhere in the State of Odisha M.Sc (Chemistry) subject was available for study. There were 8 students in our class including myself. They are: Yogendra Mohanty, Kshirod Chandra Tripathy, Balakrishna Sabat, Indu Bhusan Mishra, Niranjan Mohanty, Somnath Satpathy and Bhramarabara Roul. In our first class, Dr. Patnaik addressed us as 'Eight Jewels of Odisha State', which I cannot forget. State also expects much from us. We were the last batch of students in Ravenshaw College to have 8 seats in M.Sc (Chemistry) and subsequently, more seats were increased.

I found Dr. Patnaik a very simple & soft spoken gentleman dressed in off- white Khadi Kurta. He had a Ph. D Degree from the famous Cambridge University, U.K. He had two papers published in the renowned NATURE Journal. His dealings were very cordial and friendly manner.

I appeared in the M.Sc 6th year examination both Theory & Practical in Physical Chemistry which belonged to Dr. Patnaik. I was not expecting good marks. However, I was surprised to see that my marks in those two papers were above 80%, almost highest in the class. This was contrary to my friends' predictions. I found Dr. Patnaik quite impartial, honest and not biased at all otherwise he cannot give such high marks to a student not belonging to his group.

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At the end of the session, I requested Dr. Patnaik to give me a testimonial. He asked me to come next day and when I met him the other day, he handed over to me the typed copy of the testimonial I wanted.

After completion of my Post- Graduate Studies, it so happened that I joined the teaching profession. I strongly vouch & swear that I got my inspiration and guidance from Dr. Patnaik's Testimonial. He expects that like him I should also be simple, sincere, honest and impartial to one & all. I believe, I have tried to keep up his expectations to the utmost level possible in my life. I could also overcome my frustration during my Post-Doctoral Research at Washington State University, USA with Prof. D.S.Matteson with the help of hard work and inspirations that I obtained from Dr. Patnaik at Ravenshaw College, Cuttack.

Sir, on this auspicious occasion of your Birth Centenary Celebration, I offer my deep sense of gratitude for all your good advice & kindness which has helped me to overcome successfully many trials & tribulations of my professional & personal life as well. I was fortunate enough to preserve your testimonial carefully during these long years of my service and post-retirement life, which I cherished most.

Sir, I am proud to be one of your students & seek your heavenly blessings to swim over the passage of time for journey to eternity.

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Government of Odisha
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Phone: 9437007127

Dr. D. Patnaik, Ph.D. (Cantab) Ravenshaw College, Cuttack

Head of the Department, Chemistry Dt. 23.10.1959

Sri Pradipta Kumar Jesthi was a student of mine in the post-graduate classes. He passed the M.Sc examination this year securing a First Class. He read Physical Chemistry under me. I have found him an intelligent and hard working student. He performs experiments with precision. He is a good and thorough experimenter.

I wish him success in life.

D Patnaik
24/10/59
(D. Patnaik)

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The Architect of Positive Thoughts

Prof. Asutosh Samantaray

It's my good fortune that during the tenure of my Presidentship of Orissa Chemical Society, Birth Centenary of two Eminent Professors of Chemistry has been commemorated in the year 2018. One of them is Late Prof. Sripati Pani, Former Professor & Head, Department of Chemistry, Sambalpur University, Odisha having Ph.D from London University and whose Birth Centenary was celebrated on 8th August, 2018 at Sambalpur University. The other one was Late Prof. Dayanidhi Patnaik, Former Professor & Head, Department of Chemistry, Ravenshaw College, Cuttack who had been to Cambridge University in the year 1947 after completing his M.Sc (Chemistry) from Patna University in the year 1941. He completed his Ph.D at Cambridge University, U.K. in the year 1950 working under the supervision of Prof. R.G.W. Norrish FRS on the **"Effect of Light on the Combustion of Hydrocarbons"** and after Ph.D, he come back to Ravenshaw College to resume his duty as a Member of the Faculty. His work unequivocally established that light has profound influence on the reaction intermediates and products as well as the course of the reaction and its kinetics. These studies led to investigation on "**Flash Photolysis"** for which Prof. Norrish and George Porter got Nobel Prize for Chemistry in the year 1967.

I had the rare opportunity to be examined in the Practical Examination by Late Prof. Sripati Pani in my M.Sc 1st year class about 44 years back. But there was no occasion either to see or interest with the legendary personality Late Prof. Dayanidhi Patnaik. But I have heard a lot about this great chemist & great man who was a stunningly a positive minded person. In this small write-up, I have attempted my best to present a brief profundity of his thoughts, ideas and ideals which he cherished most.

That it requires profound courage to dream and Prof. Patnaik had mustered that courage to cherish a dream to have a Ph.D at Cambridge University in the Pre-Independence era when the nation was shattered in all fronts by the British Raj. A popular axiom penned by the famous Management Guru Sri Shiv Khera can be recalled here that...

"Winners do not do different things,
They do things differently"

Perhaps this Mantra of Success was his touch stone for attaining such great heights in a most remarkable career of a Researcher & Educationist.

In the Pre-independence era, there were no adequate facilities in communication. But he had dreamt and ventured to complete M.Sc from Patna University in the year 1941. During the course of his life, he had developed positive attitude and despite many insurmountable challenges got determined to have a Ph.D at Cambridge University, England which was a tough job during the Pre-independence era.

History reveals that most notable winners usually encounter heart breaking obstacles before they triumphed. Triumphs do not come without sustained efforts on which Prof. Patnaik had fixed his mind and thought. Since he had understood the propensity of great power of thought, success followed him all along. When a Thought Process is strongly associated with Self-Confidence, Optimism and Perseverance, undoubtedly it leads into action. These rare qualities & distinctions which got materialized in the case of Prof. Patnaik and he went to Cambridge University to fulfill his cherished ambition being adhered to stringent self discipline.

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When good thoughts are created in mind they lead the thinkers to good people and good things in life. It is often seen and observed that great things are achieved in the world by good thoughts cherished in the mind of good people. Prof Patnaik had possessed all those qualities and had imbibed this spirit fortitude and forbearance in the minds of his students and posterity as well.

To cherish a dream in pre- independence era under the conditions of scanty facilities requires tremendous courage, confidence and a sea of positive thoughts which Prof. Patnaik had preserved in his mind and heart.

Wealth and worldly powers hardly mattered for him. After having spent a remarkable career in pursuit of academic excellence and research, he abandoned his career inside the four walls of the laboratory and the classroom to join the Bhoodan Movement at the clarion call given by Acharya Vinoba Bhabe. That was a move which became the turning point in his life undoubtedly owing to his utmost concern for the hapless and hopeless common man which was inflicted on them by the British Raj. On the advice of Acharya Vinoba Bhabe, he preferred to unleash his activities at Haryana & was popularly known as "Haryana Gandhi".

As the fragrance of a jasmine spreads in all directions so also the selfless & dedicated service of Prof. Patnaik for the poor & common man spread far and wide and made him immortal . On this occasion of commemoration of Birth Centenary, I offer my heartfelt tributes to the memory of a hallowed personality and wish that the hitherto unborn future generations of not only Odisha but India should emulate the ideals for which he stood for.

He could transform every impediment into opportunities through his sheer wisdom and right understanding of the matter in their proper perspectives and could give concrete shape to his dreams and thoughts. He was both a visionary and a pragmatist and the idealism and reality met and merged in him perfectly.

Let us solute to such an impeccable personality and multifaceted erudite intellectual who has left behind indelible mark of his talent and exemplary achievements not only in the field of academics but also in social life. Let his thoughts bloom a thousand flowers in a desert.

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ସ୍ମୃତି ନୈବେଦ୍ୟ

ଶ୍ରୀମତୀ ଜୟଶ୍ରୀ ପଟ୍ଟନାୟକ

ବ୍ରହ୍ମବିତ୍, ସିଦ୍ଧ ସାଧକ, ଗୁରୁଙ୍କର ଗୁରୁତୁଲ୍ୟ ଚିରକାଳ ପରମ ଆରାଧ୍ୟ ଜଣେ ମହାପୁରୁଷଙ୍କ ବିଷୟରେ ମୁଁ ସାମାନ୍ୟତୁଲ୍ୟ କଣ ବା ଲେଖିପାରିବି । ସାହସ କରି ଲେଖୁଛି । ପାରିବି କି ନା ଜାଣିନି ।

୧୯୮୫ ମସିହାରେ ଦାଦା ଡକ୍ଟର ଦୟାନିଧି ପଟ୍ଟନାୟକଙ୍କର ଦେହାନ୍ତ ପରେ ଅଗଣିତ ସୂର୍ଯ୍ୟୋଦୟ ଓ ସୂର୍ଯ୍ୟାସ୍ତ ଏହା ଭିତରେ ଚାଲି ଗଲାଣି । କିନ୍ତୁ ଲାଗେ ଦାଦା କେବେ ପୁଣି ଫେରି ଆସିବେ । ବୋଧହୁଏ, ଏଇ ଘରର ଦାୟାଦଙ୍କ ଭିତରେ ସେ ଫେରି ଆସିଛନ୍ତି, ଆମେ ଜାଣି ପାରୁନୁ ।

ଦାଦାଙ୍କୁ ପ୍ରଥମ ସାକ୍ଷାତ କଲା ବେଳକୁ ମୁଁ ପଟ୍ଟନାୟକ ପରିବାରରେ ୧୪ବର୍ଷର ବୋହୂ ହୋଇ ସାରିଲିଣି । ଆମେ ସେତେବେଳେ ଆଇ.ଆଇ.ଟି ବମ୍ବେରେ ଥାଉ । ମୋ ସ୍ୱାମୀ ପ୍ରଫେସର ପ୍ରଶାନ୍ତ କୁମାର ପଟ୍ଟନାୟକ କହିଲେ ଦାଦା ଗୋହତ୍ୟା ନିରୋଧ ଅଭିଯାନରେ ବମ୍ବେ ଆସିଛନ୍ତି । ସେତେବେଳେ ଦାଦା ବମ୍ବେରେ ଘାଟକୋପର ସର୍ବୋଦୟ ଆଶ୍ରମରେ ରହୁଥାନ୍ତି । ମନରେ ଇଚ୍ଛା ପ୍ରବଳ ହେଲା । କେତେ ଜଲ୍‌ଦି ଦାଦାଙ୍କର ଦର୍ଶନ ହବ । କେତେ ଜଲ୍‌ଦି ଯିବି ଦେଖା କରିବି । ମନ ଉଚ୍ଚାଟ ହେବାରୁ ସାଙ୍ଗେ ସାଙ୍ଗେ ଦାଦାଙ୍କୁ ଦେଖା କରିବାକୁ ବାହାରିଲୁ ।

ସର୍ବୋଦୟ ଆଶ୍ରମ ଭିତରେ ପ୍ରବେଶ କଲା ମାତ୍ରେ ଦୁଇ ପଟରେ ନାରାୟଣ ଭୋଜନ ଦିଆଯାଉଥାଏ । ତାକୁ ପାରି କରି କିଛି ଦୂରରେ ଦେଖିଲି ବଡ ଏକ କୃଷ୍ଣ ଚୂଡ଼ା ଗଛ ମୂଳରେ ଚବୁତରାଟିଏ ଅଛି । ତା ଉପରେ ବିରାଜମାନ ଜଣେ ଜ୍ୟୋତିର୍ମୟ ମହାପୁରୁଷ । ଶୁଭ୍ର ବସ୍ତ୍ରରୁ ତାଙ୍କର ଜ୍ୟୋତି ବାହାରିଲା ପରି ଦିଶୁଥାଏ । ମୁଁ ତାଙ୍କୁ ଭୂମିଷ୍ଠ ପ୍ରଣାମ କରିବାର ସୌଭାଗ୍ୟ ପାଇଥିଲି । ମୋ ସ୍ୱାମୀ ଦାଦାଙ୍କୁ ଚିହ୍ନା କରେଇଦେଲେ । ଦାଦା ଭାରି ଖୁସୀ ହୋଇଗଲେ । ପରେ ପରେ ମୁଁ ତାଙ୍କୁ ଅନୁରୋଧ କଲି ଆମ ଘରକୁ ଆସିବା ପାଇଁ । ମନରେ ବାରମ୍ବାର ଯୁକ୍ତି ଆସୁଥିଲା ଯାହାର ସିନା କେହି ନାହିଁ ସେ ଗଛ ମୂଳରେ ରହିବ, ଦାଦା କାହିଁକି ରହିବେ । ଦାଦା ମୋ ଯୁକ୍ତି କାଟି ଦେଲେ, କହିଲେ ସେ ସନ୍ୟାସ ବ୍ରତ ଗ୍ରହଣ କରିସାରିଛନ୍ତି । ମୁଁ ପୁଣି ଯୁକ୍ତି ବାଢ଼ିଲି ତାଙ୍କର ପିନ୍ଧା ଲୁଗାପଟା ସଫା କରି ନେଇ ଆସିବା ପାଇଁ । ଦାଦା ବ୍ୟସ୍ତ ହୋଇଗଲେ । କହିଲେ ତମେ ତ ବଡ ନଛୋଡବନ୍ଧା । ହଉ ତେବେ ସେହି କାମଟା କରିପାର । କିନ୍ତୁ ମୋ ଲୁଗା ପିଲାଙ୍କ ଲୁଗା ସାଙ୍ଗରେ ପକେଇବନି । ଆମେ ବାହାରେ ବୁଲୁଛୁ ନା ସେଇଥିପାଇଁ । ମୁଁ ତାଙ୍କ କଥାରେ ରାଜି ହୋଇ ଲୁଗା ନେଇ ଆସି ତା ପରଦିନ ସଫାଲୁଗା ପହଞ୍ଚେଇବାକୁ ଗଲି । ଅନୁରୋଧ ଓ କାକୁତି ମିନତୀ ହୋଇ କହିଲି ଆପଣଙ୍କୁ ଆପଣଙ୍କ ନାତି ନାତୁଣୀଙ୍କ ପାଇଁ ନିଶ୍ଚୟ ଆସିବାକୁ ପଡିବ । ମୁଁ କିଛି ଶୁଣିବିନି । ସେମାନେ ମତେ ବିଶ୍ୱାସ କରୁନାହାନ୍ତି । ଆପଣ କେତେ ଜ୍ଞାନୀ । ତାଙ୍କ ସାଙ୍ଗରେ କିଛି ସମୟ ବିତେଇବାକୁ ଅନୁରୋଧ କଲି । ଦାଦା ଆଉ ପାରିଲେନି । ଗୋଟିଏ ସର୍ତ୍ତରେ ମୋ ଘରକୁ ଆସିଲେ । ରାତିରେ ରହୁନଥିଲେ । ମୋ ପିଲାମାନେ ବହୁତ ଜ୍ଞାନ ଆହରଣ କରିପାରିଛନ୍ତି ତାଙ୍କଠୁଁ । ପିଲା ବୟସରେ ଯାହା ଜ୍ଞାନ ପ୍ରାପ୍ତ ହୁଏ ତାହା ସାରା ଜୀବନ ପାଇଁ ରହିଯାଏ । ଆଜିବି ମୋ ପିଲାମାନେ ପ୍ରଶଂସିତ କେବଳ ଦାଦାଙ୍କର ପ୍ରଭାବ ଯୋଗୁ । ମୋ ସ୍ୱାମୀ ପ୍ରଫେସର ପ୍ରଶାନ୍ତ କୁମାର ପଟ୍ଟନାୟକଙ୍କର ଜୀବନ ଆରମ୍ଭ ହୋଇଛି ଦାଦାଙ୍କର ଆଦର୍ଶରେ । ଈଶ୍ୱରଙ୍କ ଇଚ୍ଛା ବିନା ଏ ସଂସାରରେ କିଛି ବି ସମ୍ଭବ ହୁଏନି । ଦାଦାଙ୍କର ବମ୍ବେ ଆସିବା ଆମ ପରିବାର ପାଇଁ ଆଶୀର୍ବାଦ ଥିଲା । ଆମ ଘର ମନ୍ଦିର ହୋଇ ଯାଇଥିଲା । ଏତେ ବଡ ପୁଣ୍ୟାତ୍ମାଙ୍କୁ ଆମ ଓଡିଶାରେ କେହି ବୁଝି ପାରିଲେନି । ତାଙ୍କ ଠାରୁ ଶିକ୍ଷା ପ୍ରାପ୍ତ କରିବା ପରିବର୍ତ୍ତେ ତାଙ୍କୁ ଓଡିଶାରୁ ଦୂର କରିଦେଲେ । ତାଙ୍କ ମୁଖର ବାଣୀ ଆମ ଚେତନାର ଆଧାର ଥିଲା । ପ୍ରତ୍ୟେକ ଶବ୍ଦର ଅନେକ ମୂଲ୍ୟ ଥିଲା । ମତେ କହୁଥିଲେ ସେ ଟିଭିଟାକୁ ଘରୁ ବାହାର କରିଦିଅ । ପିଲା ଖାଲି ବହି ପଢନ୍ତୁ ।

ଦାଦା ଆଜି ବି ଆମ ସମସ୍ତଙ୍କ ଭିତରେ ଜୀବିତ ଅଛନ୍ତି । ତାଙ୍କ ମୁଖ ନିସୃତ ବାଣୀ ଏ ପର୍ଯ୍ୟନ୍ତ ମନରେ ବାଜୁଛି । ଜାତୀୟତାବୋଧ ଓ ଧର୍ମ ଭାବ ଉପରେ ଆଧାରିତ ତାଙ୍କର ଉପଦେଶ ଆମ ସମସ୍ତଙ୍କ ଭିତରେ ଉଜ୍ଜଳ ହେଇ ରହିଥିବ । ତାଙ୍କର ମୁଖ୍ୟ ଉଦ୍ଦେଶ୍ୟ ଥିଲା କେହି ଲୋକ ଅନାହାର, ଅନାଦର ରହିବା କଥା ନୁହେଁ । ମୁଁ ଘରକୁ ଯେ କୌଣସି ବ୍ୟକ୍ତି ଆସିଲେ ତାଙ୍କୁ ପେଟ ଭରି ଅନ୍ନଦବା ଗୁଣଟା ଦାଦାଙ୍କଠୁଁ ହିଁ ଶିଖିଛି । ତାଙ୍କର ପ୍ରଥମ କଥା ଥିଲା- "ବୋହୂ, ସମସ୍ତଙ୍କୁ ଖାଲି ଦିଅ, ଯେତେ ଦେଇ ପାରିବ ଦିଅ ।"

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ଦାଦାଙ୍କର ନୂତନ ଚିନ୍ତାଧାରା, ନୂତନ ଦିଗ୍‌ଦର୍ଶନ ହିଁ ତାଙ୍କର ଜୀବନଧାରାକୁ ଆହୁରି ସଞ୍ଜିତ ତଥା ଆଦର୍ଶ ଜୀବନ ଯାପନ କରିବାରେ ସକ୍ଷମ କରିଥିଲା । ସେବା ମନବୃତ୍ତି ତାଙ୍କ ବ୍ୟକ୍ତିତ୍ୱର ଅନ୍ୟଏକ ପ୍ରମୁଖ ଦିଗ ଥିଲା । ସେ ଜଣେ ଭଲ ହୋମିଓପାଥିକ ଡ଼ାକ୍ତର ଥିଲେ । ମୋର ଜଣେ ଅତି ନିକଟତମ ବନ୍ଧୁ ଶ୍ରୀମତୀ ପ୍ରଭା ଚତୁରାନୀ ବୋଲି । ଦାଦାଙ୍କର ଚିକିତ୍ସାରେ ସେ ପୂରାପୂରି ସୁସ୍ଥ ହୋଇଯାଇଥିଲେ । ପରେ ମୋ ଘରକୁ ଦାଦାଙ୍କ ଉପକାର ଭୁଲିପାରିବେନି କହି ଭଲ ଉପହାରଟିଏ ଧରି ଆସିଥିଲେ । କିନ୍ତୁ ଦୁର୍ଭାଗ୍ୟ, ଦାଦା ସେତେବେଳକୁ ସଂସାରରେ ନଥିଲେ ।

ମତେ ଦାଦାଙ୍କଠୁଁ କିଛି ହୋମିଓପାଥିକ ବହି ମିଳିଥିଲା ପ୍ରାରମ୍ଭରୁ ହୋମିଓପାଥିକ ଉପରେ କିଛି ଜ୍ଞାନ ଆହରଣ ପାଇଁ । ସେଥିପାଇଁ ମୁଁ ଦାଦାଙ୍କ ପାଖରେ ଚିର କୃତଜ୍ଞ ।

ବମ୍ବେରୁ ଫେରିବା ପୂର୍ବରୁ ଦାଦା ମତେ ଥରେ ପଚାରିଲେ "ତମର ଆଉ ସବୁ କ'ଣ ବାକି ରହିଲା ?" ଭଗବାନ ସବୁ ତ ଦେଇଛନ୍ତି ତୁମକୁ । ଏଡ଼େ ସୁନ୍ଦର ଗୁଣର ପିଲାମାନେ ତୁମ କୋଳକୁ ଆସିଛନ୍ତି । ଏଘରଟା ତମର ଆଶ୍ରମଠୁଁ କିଛି କମ୍ ନୁହେଁ । ପୁଅଟା ମୋର ଏତେ ଭଲ । ଆଉ କ'ଣ ଦରକାର ତମର ?

ମୁଁ କହିଲି ମୋ ପୁଅ ତଥା ଆପଣଙ୍କ ନାତି ମୋଟେ ଭଲ ହେଇନି । ହୋମ୍ ୱାର୍କ କରୁନି । କ୍ଲାସ୍ ୱାର୍କ କରୁନି । ସେଥିପାଇଁ ମୋ ମନରେ ବଡ଼ ଦୁଃଖ । ଦାଦା ଦି ନାତିଙ୍କୁ ଡ଼ାକିଲେ । ବଡ଼ ଦାଦା ହରମୋହନ ପଟ୍ଟନାୟକଙ୍କର ନାତି ଭାରି ବୁଦ୍ଧିଆ ହୋଇଥାଏ । ଦି ନାତିଙ୍କୁ ପାଖରେ ବସାଇ କହିଲେ "ଦେଖ ଭଗବାନ ତମ ପାଖରେ ହଠାତ୍ ଯଦି ଆସି ପହଞ୍ଚିଯିବେ ଆଉ ତୁମକୁ ଦୁଇଟି ବରଦାନ ଦେବାକୁ ଇଚ୍ଛା ପ୍ରକାଶ କରିବେ ତା'ହେଲେ ତୁମେ ଭଗବାନଙ୍କୁ କ'ଣ ବର ମାଗିବ ? ବଡ଼ ନାତିଟି କହିଲା "ଯାଉନ ଜେଜେ, ଡ଼ାକିଦେଲେ ଏମିତି ଖାଲି ଭଗବାନ ଆସିଯିବେ ? ଦାଦା କହିଲେ ହଁ ନିଶ୍ଚୟ ଆସିଯିବେ । ମନ ଧ୍ୟାନ ଲଗେଇ ଡ଼ାକିଲେ ଠାକୁର ନିଶ୍ଚୟ ଆସିବେ । ବଡ଼ ନାତିର ଆଖି ଦୁଇଟି ଉଜ୍ଜ୍ୱଳ ଦିଶିଲା । ତାର ସ୍ମରଣ ଶକ୍ତି ବି ଭାରି ପ୍ରଖର ଥିଲା । ସେ କେତେ ମୋଟର ଗାଡ଼ିର ମଡ଼େଲର ନାଁ ମନେ ରଖିଥିଲା ସବୁ ଭଗବାନଙ୍କୁ ମାଗିଦେଲା । ଭଗବାନଙ୍କୁ ଆଉ ଗୋଟିଏ ୬୦ ମହଲା ଘରବି ମାଗିଲା । ଦାଦା ଭାରି ବ୍ୟସ୍ତ ହୋଇପଡ଼ିଲେ । ଏତେ ଟିକେ ଛୁଆ କ'ଣ ସେ ମାଗିଦେଲା ! ତା'ପରେ ଆମ ପୁଅର ପାଳି । ସେ ବୁଢ଼ାଟିଏ ଭଳି ଗୋଟେ ଜାଗାରେ ବସି କ'ଣ ସବୁ ଭାବୁଥାଏ । ଦାଦା ତାକୁ ପୁଣି ପଚାରିଲେ, ମାଗ କ'ଣ ତୁମେ ମାଗୁଛ ଠାକୁରଙ୍କୁ ମାଗ । ମୋ ପୁଅ ଠାକୁରଙ୍କୁ ମାଗିଲା "ସଂସାରରେ ଯେପରି କୌଣସି ଲୋକ ଭୋକିଲା ରହିବେନି । ସମସ୍ତଙ୍କୁ ପେଟପୂରା ଖାଇବାକୁ ମିଳୁଥିବ । ଆଉ ଦ୍ୱାର ଦ୍ୱାର ବୁଲି ତାଙ୍କୁ ଭିକ ମାଗିବାକୁ ପଡ଼ିବନି । ସମସ୍ତଙ୍କୁ ପିନ୍ଧିବାକୁ ଲୁଗାପଟା ଖଣ୍ଡେ ମିଳୁଥିବ ।" ପୁଅର ଏଭଳି ମିନତୀ ଶୁଣି ମୁଁ ଆଶ୍ଚର୍ଯ୍ୟ ହୋଇଗଲି । କେତେ ସାମୂହିକ ଚିନ୍ତାଧାରା ପିଲାଟାର ! ସମସ୍ତଙ୍କ ପାଇଁ ଚିନ୍ତା କରୁଛି । ସମସ୍ତଙ୍କ ପାଇଁ ଗୁହାରି କରୁଛି ଠାକୁରଙ୍କ ପାଖରେ । ମୋ ପୁଅର ଏଭଳି ମିନତୀରେ ଦାଦା ମତେ କହିଲେ "ବୋହୂ ତମେ ଫେଲ୍ ମାରିଗଲ" । ମତେ ଆଶ୍ଚର୍ଯ୍ୟ ଲାଗିଲା ଏମିତି କ'ଣ ସେ ଠାକୁରଙ୍କୁ ମାଗୁଛି । ଆମ ଘରେ ନାରାୟଣ ଭୋଜନ ଦିଆଯାଉଥିଲା ବେଳେ ସେ ପ୍ରଥମ କରି ଭିକାରୀ ଦେଖିଥିଲା । ସେବେଠାରୁ ଭିକାରୀମାନଙ୍କର ଛାପ ତା' ମନ ଭିତରେ ବସାବାନ୍ଧି ରହିଥିଲା । ତେଣୁ ସେ ଭଗବାନଙ୍କୁ କେହି ଲୋକ ଯେପରି ଉପାସରେ ନରହିବେ ସେଥିପାଇଁ ମିନତୀ କରିଥିଲା । ଦାଦାଙ୍କର ଏହି ଦୁଇ ନାତି ଏବେ ଲଣ୍ଡନ ଓ କାନାଡ଼ାରେ ବ୍ୟାଙ୍କ୍ ଅଫିସର ଭାବେ କାର୍ଯ୍ୟରତ । ଭାରି ଭଲପିଲା ହୋଇଯାଇଛନ୍ତି । ସେମାନଙ୍କର ଦୁଇପୁଅ ମଧ୍ୟ ଭାରି ଭଲପିଲା ।

ଦାଦାଙ୍କ ବିଷୟରେ ଲେଖିବାକୁ ବସିଲେ ଗୋଟିଏ ବୃହତ୍ ଶିକ୍ଷାପ୍ରଦଗ୍ରନ୍ଥ ହୋଇଯିବ । ତାଙ୍କର ଦୃଷ୍ଟାନ୍ତ ପରିଦୃଷ୍ଟାନ୍ତ ଜଗତରେ ବିରଳ । ତାଙ୍କଠୁଁ ଅନୁପ୍ରାଣିତ ହୋଇ ମୁଁ ଦିନେ ଗୋଟିଏ ଲୋକର ଖାଇବା ଆମେ ସମସ୍ତେ ଘରେ ଖାଇବା ଆଗରୁ ବାଢ଼ିକରି ଅଲଗା ରଖିଦେଲି । ଆମର ଆଇ.ଆଇ.ଟି କ୍ୟାମ୍ପସ୍ ଭିତରକୁ ପାସ୍ ନଥିଲେ କେହି ଆସିପାରନ୍ତିନି । ଭାବିଲି ମୋ କାମ'ତ ମୁଁ ପୂରାକଲି । ତେଣିକି କିଏ ଯଦି ଦୁଃଖୀ ରଙ୍କି ଲୋକ ଆସିବେ ତାଙ୍କୁ ମୁଁ ଏ ଖାଦ୍ୟ ଦେଇଦେବି । ହଠାତ୍ ଦାଣ୍ଡଦୁଆରେ କାହାର ମା' ମା' ଡ଼ାକ ଶୁଭିଲା । ଯାଇ ଦେଖେତ ଭୋକିଲା ଲୋକଟିଏ ପେଟରେ ହାତ ଠାରି ଖାଇବାର ଇସାରା କରୁଛି । ସାଙ୍ଗେସାଙ୍ଗେ ରୋଷେଇ ଘରକୁ ଯାଇ ବଢ଼ାହୋଇଥିବା ଅନ୍ନ ଓ ତରକାରି ତାକୁ ଦେଇଦେଲି । ଲୋକଟି ଆନନ୍ଦରେ ଖାଇ ମୋତେ ଆଶୀର୍ବାଦ କରି ଚାଲିଗଲା । ମୁଁ ବି ଘର ଭିତରକୁ ଚାଲିଆସିଲି । ମୋର ସ୍ୱାମୀ ପ୍ରଫେସର ପ୍ରଶାନ୍ତ କୁମାର ପଟ୍ଟନାୟକ ଲଞ୍ଚ୍ ବ୍ରେକ୍‌ରେ ଆଇ.ଆଇ.ଟିରୁ ଘରକୁ ଆସିଲେ । ମୁଁ ଏକଥା ତାଙ୍କୁ କହିଲି । ସେ ଜମା ବିଶ୍ୱାସ କଲେନି । ସେ ଘର ବାହାରେ ବୁଲି ଦେଖିଆସିଲେ । କହିଲେ, କାହିଁ କେହି ତ ନାହାନ୍ତି ? ତୁମେ କଳ୍ପନା କରୁନ ତ ? ମୁଁ ଭିକାରୀ ପାଇଁ ବାଢ଼ିଥିବା ଖାଲି ଥାଳିଟି

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ଦେଖାଇଲି । ସେ ମତେ କହିଲେ, ତୁମେ ଲୋକଟିକୁ ମୁଣ୍ଡିଆ ମାରିଲ ? ମୁଁ କହିଲି ନାଁ । ତାହେଲେ ତୁମେ ସୁଯୋଗ ହରେଇଲ । ଭଗବାନ ଆଜି ଆମ ଘରକୁ ଆସି ଫେରିଗଲେ !

ଦାଦାଙ୍କ ପ୍ରେରଣାରେ ଅନୁପ୍ରାଣିତ ହୋଇ ମୋର ଈଶ୍ୱରଙ୍କ ଉପରେ ଅଗାଧ ବିଶ୍ୱାସ । ଥରେ ମୋ ପୁଅ ବାହାଘର ପରେ ବୋହୂ ଘରକୁ ଆସିବା ଆଗରୁ କିଛି ଫୁଲର ଦରକାର ଥିଲା । ସକାଳ ଛଅଟା । ବୋହୂ ଆସି ଏବେ ଘରେ ପହଞ୍ଚିଯିବ । ଫୁଲ ଏବେ ମୁଁ କୋଉଠୁ ଆଣିବି ? ହଠାତ୍ ଜଣେ ଢେ଼ଙ୍ଗା ହୋଇ ଲୋକଟିଏ ଅସମ୍ଭବ ଫୁଲର ଭାରଟିଏ ନେଇ କୋଉଠୁ ଆସି ମୋ ଘର ଆଗରେ ଉଭା ହୋଇଗଲା । ମୁଁ ଖୁସିରେ ଗଦ୍ ଗଦ୍ ହୋଇଗଲି । ସବୁତକ ଫୁଲ ମୁଁ ସେ ଲୋକଠୁଁ ରଖିନେଲି । କୃତଜ୍ଞତାରେ ମୋ ମୁଣ୍ଡ ନଇଁଗଲା ଈଶ୍ୱରଙ୍କ ପାଖରେ । ଈଶ୍ୱରଙ୍କ କୃପା ଅବର୍ଣ୍ଣନୀୟ । ଲେଖିଲା ବେଳକୁ ଲାଗୁଛି ମୁଁ କ'ଣ ଧର୍ମ ଗ୍ରନ୍ଥ ଲେଖୁଛି ନା ସତକଥା ଲେଖୁଛି ।

ଦାଦାଙ୍କର ସମସ୍ତଙ୍କ ପାଇଁ ଥିଲା ଅପରିସୀମ ସଦ୍‌ଭାବନା । ଦାଦାଙ୍କ ଭାଗରେ ଯାହାକିଛି ପୈତୃକ ଜମି ଥିଲା ତାକୁ କିଛି ଆଖ ପାଖ ଦଶ ଖଣ୍ଡ ଗାଁରେ ରାସ୍ତା ତିଆରି କରିବା ପାଇଁ ଦାନ କରିଦେଇଥିଲେ । ଏ କଥାଟି ଆଜି ପର୍ଯ୍ୟନ୍ତ କେହିବି ଜାଣିନାହାଁନ୍ତି । ସେ'ତ ଥିଲେ ଜଣେ ନୀରବ କର୍ମୀ । ନୀରବ ରହି କାମ କରି ଯାଆନ୍ତି । କେବେ ପଛକୁ ଅନାଇ ନାହାଁନ୍ତି । ଆଗେଇ ଚାଲିଗଲେ ଅପରିସୀମ ପଥରେ । ଶେଷ ମୁହୂର୍ତ୍ତରେ ପୂରା ବିଷ୍ଣୁସହସ୍ରନାମ ପାଠ କରି ଶେଷ ନିଶ୍ୱାସ ତ୍ୟାଗ କରିଛନ୍ତି । ତାଙ୍କର ପୂରା ପାଠ ଶେଷ ହେଲା ଓ ସେ ଦେହ ତ୍ୟାଗ କଲେ ।

ତାଙ୍କର ଶେଷ ଚିଠିଟିକୁ ମୋଠୁଁ ଆତ୍ମୀୟ ସ୍ୱଜନମାନେ ନେଇ ଯାଇଛନ୍ତି । ତାଙ୍କର ଶେଷ ଇଛା ଆମେ ପୂରଣ କରିପାରିଲୁନି । ତାଙ୍କ ଦେହାନ୍ତର ଖବର ଆମେ ଠିକଣା ସମୟରେ ଜାଣି ପାରିଲୁନି । ତାଙ୍କ ଦେହାନ୍ତର ଦି ଦିନ ପରେ ଯାଇ ଆମେ ପହଞ୍ଚିଲୁ । ବାକି ଯାହା ଦାୟିତ୍ୱ ସବୁ ତୁଲେଇଲୁ । ବିଧିର ବିଧାନ କେ କରିବ ଆନ । "ତୁ ମତେ ମୁଖାଗ୍ନି ଦବୁ" ଥିଲା ଦାଦାଙ୍କର ଶେଷ ଚିଠିର ବିଷୟବସ୍ତୁ ମୋ ସ୍ୱାମୀଙ୍କ ପାଇଁ । ହେଲେ ଆମେ ଠିକଣା ସମୟରେ ଖବର ପାଇଲୁନି । ଆମର ଦୁର୍ଭାଗ୍ୟ । ଆମ ପ୍ରତି, ଆମ ପରିବାର ପ୍ରତି ତାଙ୍କ ଆଶୀର୍ବାଦ ରହିଛି । ସବୁଦିନ ରହିଥିବ ।

ମୁଁ ଦାଦାଙ୍କର ଜଣେ ବାର୍ତ୍ତାବହ ରୂପେ ଏହି ରଚନାଟିକୁ ଅଣନିଶ୍ୱାସୀ ହୋଇ ଲେଖିଚାଲିଛି । ଅସରନ୍ତି, ଅସୀମିତ ଓ ଅସାଧାରଣ ବ୍ୟକ୍ତିତ୍ୱର ଅଧିକାରୀ ଦାଦାଙ୍କଠୁଁ ପ୍ରାପ୍ୟ କରୁଣାର ପ୍ରସାଦକୁ ଜନସମୁଦାୟଙ୍କ ପାଖରେ ବିତରଣ କରିବାକୁ ମୋର ଏ ଯତ୍ କିଞ୍ଚିତ ପ୍ରୟାସ । ମୁଁ, ମୋ ସ୍ୱାମୀ ଓ ଆମ ପରିବାରର ସମସ୍ତ ସଦସ୍ୟ ଆଜି ମୁକ୍ତ କଣ୍ଠରେ ସ୍ୱୀକାର କରିବା ସଙ୍ଗେ ସଙ୍ଗେ ଏହା ଉଦ୍‌ଘୋଷଣ କରୁଛୁ ଯେ ଦାଦା ପ୍ରଫେସର ଦୟାନିଧି ପଟ୍ଟନାୟକଙ୍କର ସବୁଠାରୁ ପ୍ରିୟ ଶିଷ୍ୟ ହେଲେ ପ୍ରଫେସର ଡ଼କ୍ଟର ବଳରାମ ସାହୁ । ସେ ତାଙ୍କର ବୌଦ୍ଧିକ ସନ୍ତାନ ଓ ତାଙ୍କ ଜ୍ଞାନବୈଭବର ପ୍ରକୃତ ଉତ୍ତରାଧିକାରୀ । ଆମେ ଜୈବିକ ଉତ୍ତରାଧିକାରୀ ହୋଇଥିଲା ବେଳେ ପ୍ରଫେସର ସାହୁ ହିଁ ଦାଦାଙ୍କର ପ୍ରକୃତ ଜ୍ଞାନ ଦାୟାଦ । ଜ୍ଞାନର ଜୟ ହେଉ । ବିଜ୍ଞାନର ଜୟ ହେଉ । ସମୟର ଜୟ ହେଉ । ସମୟ ସୁଅରେ ବାହୁଡ଼ି ଯାଇଥିବା ଦାଦା ସମୟର ସିଂହାସନରେ ଅଭିସିକ୍ତ ହୋଇ ତାଙ୍କର ଏ ମହାର୍ଘ ଜନ୍ମ ଶତବାର୍ଷିକୀ ଉତ୍ସବକୁ ଅଭିମଣ୍ଡିତ କରନ୍ତୁ । ବିଭୁଙ୍କ ଚରଣାରବିନ୍ଦରେ ଏତିକି ପ୍ରାର୍ଥନା । ଓଁ ଶାନ୍ତି । ଓଁ ଶାନ୍ତି ॥ ଓଁ ଶାନ୍ତି ।।।

ପରମ ସ୍ୱର୍ଗଲୋକରୁ ଆଶୀର୍ବାଦ ଆକାଂକ୍ଷୀ

ବୋହୂ

ଟ୍ରଷ୍ଟି-ଡକ୍ଟର ଦୟାନିଧି ପଟ୍ଟନାୟକ ମେମୋରିଆଲ୍ ଟ୍ରଷ୍ଟ
ବିଦିଶା, ବି-୪, ବିଜେବି ନଗର, ଭୁବନେଶ୍ୱର-୭୫୧୦୧୪
ଫୋନ୍: ୮୮୯୫୬୧୮୮୯୪

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Dayanidhi Patnaik at Cantab
(The Origin of Photo-Chemistry)

Dr. Chitta Ranjan Mishra

Dr. Dayanidhi Patnaik went to England in the year 1947 to work in the intellectual climate of the University of Cambridge with Professor R G W Norrish. Then Cambridge was the metropolis of experimental Chemistry in the world. Professor Norrish at this time was deeply engaged in the study of thermal decomposition of hydrocarbons, an area of investigation that was being intensely studied for the preceding two decades. The decomposition work was first pioneered by the British Chemist and Nobel Prize winner Hinshelwood and the Soviet physical chemist and Nobel Prize winner N N Semenov (Prof. Patnaik reports the three distinguished scientist in the opening lines of his thesis).

N N Semenov

Sir Hienshelwood

Sir Hienshelwood was noted for his achievement in studying the complexities involved in the chemical reaction between hydrogen and oxygen that produces water. He also made significant contribution to the understanding of chain reactions or chain branching particularly in explosive reactions. His work led to the 1956 Nobel Prize in Chemistry which he shared with the Soveit Chemist N N Semenov.

Semenov's work was in the branch of Physical Chemistry that concerns the rates and conditions of chemical processes. His greatest contribution in the field of Chemical Kinematics involved investigating thermal combustion in which the heat given off by some gaseous explosions does not dissipate but instead raises the temperature around the explosion which could cause chain reactions. Semenov's work into branch chain reactions and their role in thermal combustion mirrored much of the work of Hienshelwood. His work provided a better understanding of the radicals when molecules disintegrate.

The investigations of Hienshelwood were followed up (during 1930- 1947) and intensive studies were carried out by several workers under varying conditions and the results of experimental data were used to advance theories for oxidation of hydrocarbons.

In 1929, a straight chain degradation scheme was proposed by Pope and co-workers while in 1946 Walsh advanced a peroxidation theory. The latter theory afforded a reasonable explanation for finding the oxidation of higher hydrocarbons but it was inadequate enough to explain the oxidation of methane and ethylene when carried out at higher temperature. In 1948, Norrish and co-workers advanced a strong evidence to show that formaldehyde was an important intermediate in the oxidation of methane and ethylene, which also pointed to the fact that higher aldehydes like wise, may play in the oxidation of higher hydrocarbons.

In the intervening period Bone and Gardiner (1936) in studying oxidation of methane contended that ultra violet light had no effect on the oxidation process. On the other hand Bennet studying the

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ultraviolet light radiation on combustion of various fuels found that the action of light lowers the temperature of initial combustion.

Here began the subject matter of research of Dayanidhi Patanaik with the aim in advancing evidence to show that the assumption of formaldehyde is the important intermediate proposed by Norrish and co-workers.

The absorption bands of formaldehyde had been studied. Patanaik used an intense source of light in the near ultra violet region with a view to bring about photochemical changes of formaldehyde which would produce additional effects in the kinetics of methane, ethylene and higher hydrocarbons.

After a period of seven decades when one reviews his work "The choice of subject of investigation" one realises the genius of his mind and firmness of his purpose.

His celebrated work unambiguously revealed that light has indeed a significant effect on the combustion of hydrocarbons. His work opened a new era of research known as 'Photo-Chemistry', study of the effect of light on chemical reactions.

His research needed new experimental arrangements and method of analysis. These are given in Appendix-I and II along with a few graphic presentations of his experimental data.

He returned to India and rejoined his Alma matter in 1949.

Perspective:

Prof. Norrish continued researching on the phenomenological discovery of Photochemical decomposition of hydrocarbons of Patanaik, with his student George Porter. They studied extremely fast reactions using short pulses of light, 'Flash Photolysis' discovering some of the intermediate states in complex chemical reactions involving organic compounds. Norrish was awarded the 1967 Nobel Prize along with George Porter and the German Physical Chemist Eigen Manfred. Eigen used a tiny electrical pulse to measure relaxation time that produces $H^{+} + OH^{-} = H_2O$, in acid base reactions.

Eigen Manfred

R.G.W.Norrish

George Porter

Photochemical investigation of chemical reactions has become ubiquitous in today's chemical world. Using laser beams it has become possible to investigate picosecond reactions.

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Appendix- I

Experimental Method

The general arrangement of the apparatus is shown in figure 1. A horizontal electric furnace, provided at one end with a window consisting of two quartz plates 7cms in diameter cemented parallel to each other 1 cm apart, was used. This double quartz window minimised the heat loss. The furnace had three windings in series along its length. Each of these windings had a shunt and was connected to an ammeter. The current could thus be adjusted so as to compensate for the loss of heat occurring to different degrees in different sections along the furnace. By the method of trial, the current in different sections was so adjusted that the temperature, in that part of the furnace where the reaction vessel was situated, was uniform to 1° C. the current for the furnace was drawn from a constant voltage supply. Temperature was measured by a chromel-alumel thermocouple; the potential developed being read by a C.I.C. potentiometer. The above thermocouple with the cold junction in melting ice was calibrated by using as fixed points the melting points of tin, lead, zinc and antimony. The inside of the furnace was lined with polished aluminium.

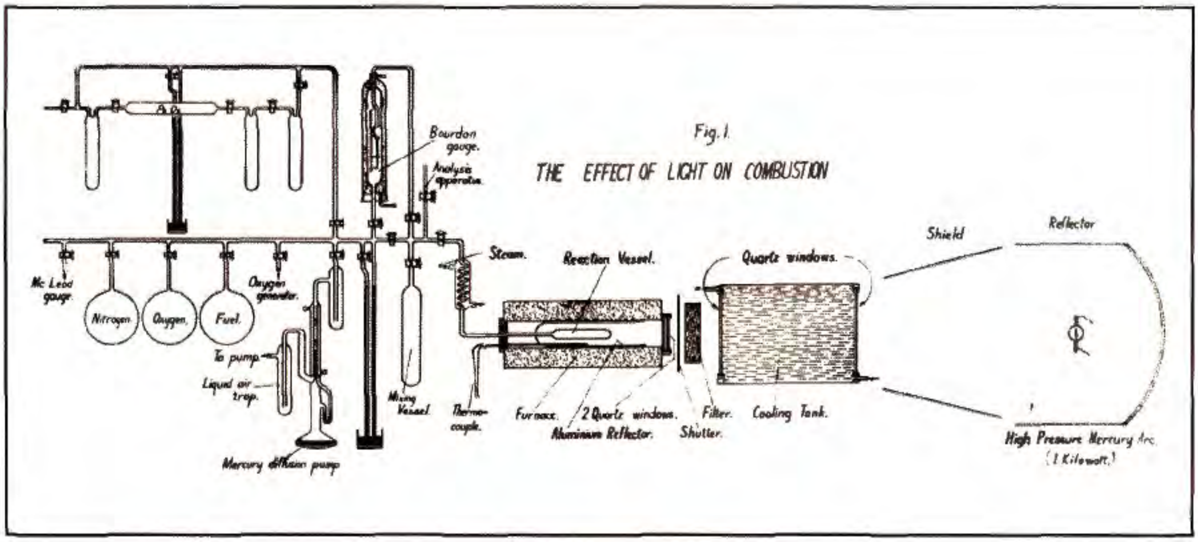

Fig. 1.
THE EFFECT OF LIGHT ON COMBUSTION

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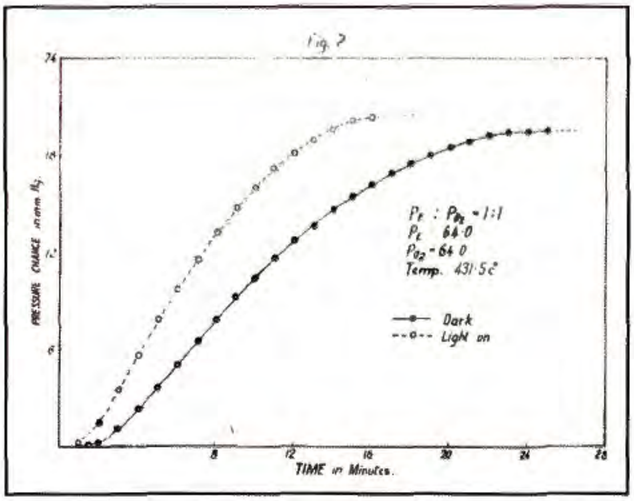
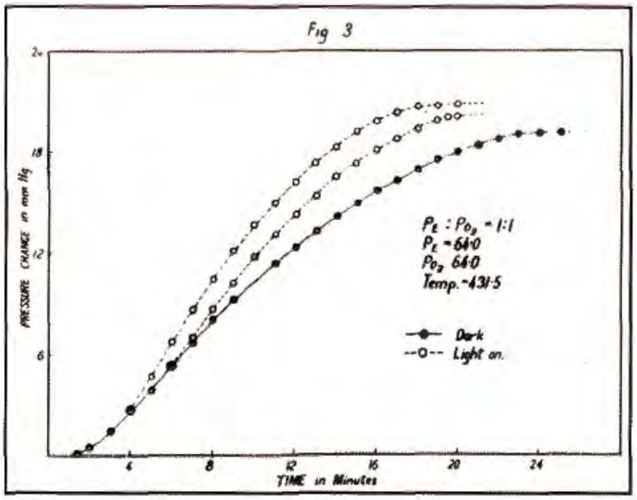
In addition to mercury manometer, two types of glass spoon gauges (the mirror type and the pointer type) were used. These three types of pressure measuring devices were so connected to the rest of the apparatus that any of them, according to accuracy needed, could be brought into operation. The mirror type was sensitive to a pressure of 0.1 mm of mercury and the pointer type to 0.04 mm. A travelling microscope was used for reading the pointer type which was in turn calibrated with respect to the manometer.

Cylindrical quartz reaction vessels of internal diameter 3.4 cm were used. The reaction vessel was supported axially and horizontally as shown in figure 1 and was connected to a quartz spiral enclosed in a jacket through which steam was passed. This was effective in preventing the consideration of reaction products e.g. water etc. which would otherwise affect the pressure measurement. This quartz spiral was joined to the rest of the apparatus made of pyrex glass, through ground joints. The taps were so arranged that the reaction vessel could be connected to the pumping line, any of the pressure measuring devices, analysis vessel, TÖpler pump, either separately or in any of their combinations. The mixing vessel was a detachable one, containing a few pieces of thin closed capillary tubes to stir the gases when the vessel was detached and inverted a number of times. This would ensure complete mixing even when the gases taken in, vary widely not only in their densities but also in their proportions.

Light- The source of ultra-violet radiation was a hot high pressure mercury lamp consuming 1 k.w. When the arc was struck for about 15 minutes, the power consumption of the lamp attained almost a steady value, any fluctuated being compensated for, from time to time, by varying the resistances in series with the lamp. A cylindrical beam of light, 7 cm in diameter and 50 cm of cold water constantly circulating in a tank provide with two parallel quartz plates. The reaction vessel inside the furnace was placed in such a way that this parallel beam entering through the quartz window of the furnace uniformly illuminated the vessel. The various light filters used in the experiment were placed in front of the quartz window of the furnace. An electrically operated shutter was used for allowing the beam to illuminate the vessel at any desired moment.





Graphic presentation of a few results

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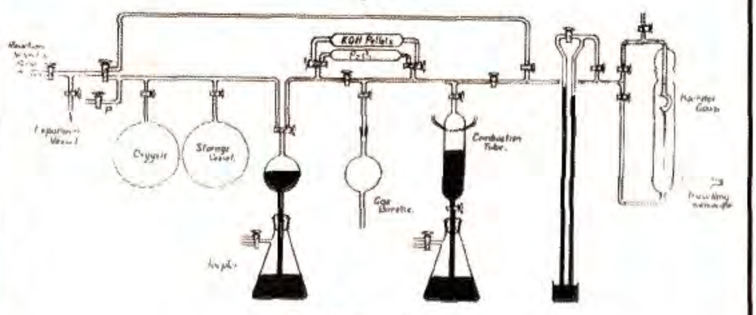
Appendix - II

Apparatus and Analysis

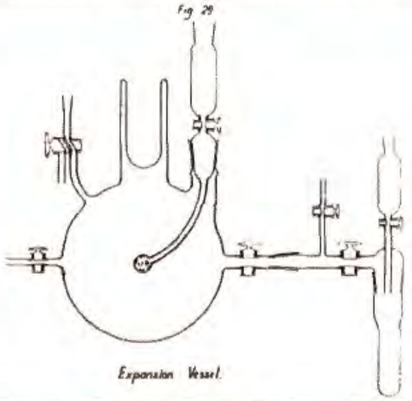
The apparatus was developed to suit the requirement for complete analysis. The reaction products might consist of saturated and unsaturated hydrocarbons, H_2, CO, CO_2, aldehydes, acids, alcohols, peroxides and water. In addition to these the amounts of unused reactants namely butane and oxygen had to be estimated. So before making complete analysis of a single run, it was necessary and adversable, to carry out some experiment for eliminating the estimation of those products from analysis, which were either absent or if present, were in negligible amounts. This not only made the analysis much simpler but as well contributed greatly to the accuracy of the estimations. It should be started here, however, that the formation of any new substance from one run to another, is extremely unlikely, when as a matter of fact, the amounts of products from different runs vary within a few percent. Moreover, no conclusion as to the absence of any particular kind of product, for example the unsaturates, was made without taking two separate runs into considerations.

Fig 28



Apparatus for Analysis

Fig 29



Expansion Vessel.

The analysis apparatus is shown in (Fig 4). It consisted essentially of two parts, one of which was a vessel (Fig 5) of capacity 2300 cc having a thimble at the top, an arrangement for squiring in the centre of the vessel with any liquid and a side trap which could be cooled for condensing any fraction or the whole of the condensibles of the reaction products. This side trap had also the arrangement for squiring with a liquid reagent without letting air in and could be detached from the main vessel and reattached to P (Fig. 4), so that any gas left undissolved or unreacted with the liquid reagent could be isolated and analysed. We shall hereafter refer to this entire vessel as expansion vessel. The other parts of the analysis apparatus consisted of a vessel for containing oxygen, another vessel for storing reaction products, and a TÖpler Pump. To the TÖpler was connected a line consisting of a gas burette with a thin narrow tubing attached to the bottom (gas burettes of different sizes according to need could be fitted to the line). There were also attached with suitable arrangements of types, a tube containing phosphorus pentoxide and other containing pellets of caustic potash. For purposes of combination a cylindrical vessel with sealed platinum spiral at one end and operating on TÖpler pump principle was also attached to the line. The platinum spiral could be heated electrically. As previously mentioned, any part of the analysis apparatus could be joined either to the vacuum pump or to different pressure measuring devices.

The capacities of the different parts of the analysis apparatus were carefully measured were carefully measured before assembling them together, and in order to check these and also to account for

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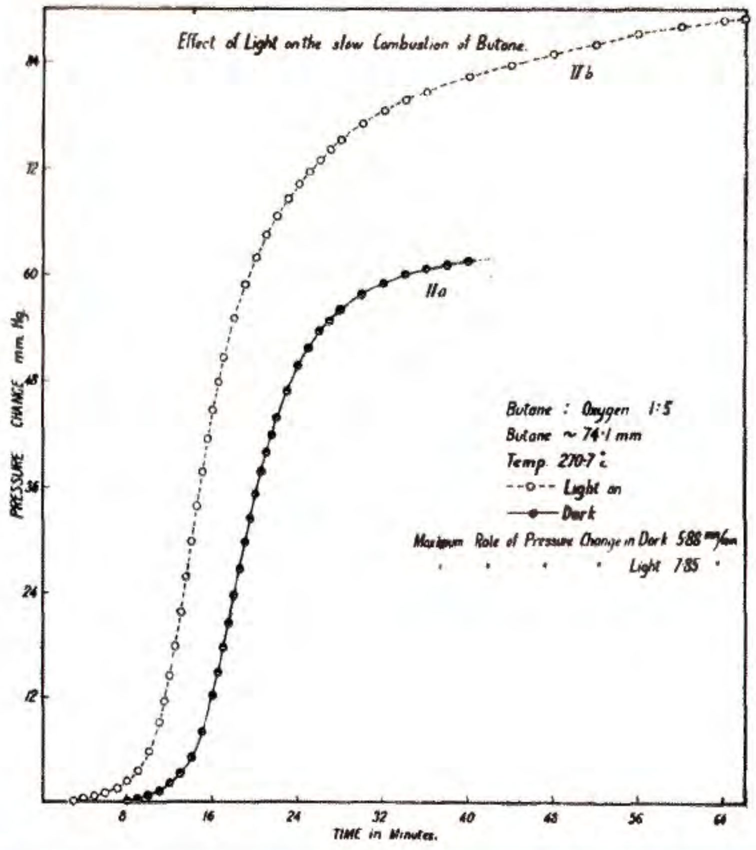
Fig 31



the slight changes which might have been brought about due to glass blowing, the method of determining the ratio of sharing the pressure with respect to one standard vessel, was employed. We have already mentioned the thimble belonging to the expansion vessel and the narrow tube attached to the bottom of the gas burette, which was meant to be cooled with different cooling agents for selective condensation. It was obvious that while certain ingredients were condensed with a particular cooling agent, the noncondensibles for that agent were no doubt cooled to certain extent. It was, therefore, necessary to ascertain the difference of temperature between the surrounding and the gas inside the vessel which resulted due to the cooling agent. For his purpose, oxygen was taken in the vessel concerned and its pressure measured accurately. The different cooling agents were then used one by one, and the depression of pressure in each case noted, from which the difference of temperature with respect to the known initial surrounding temperature could be calculated. Allowances for such differences of temperature were made in respective calculations.

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The Crucibles of Chemistry: Ravenshaw College, Cuttack

Prof. Balaram Sahoo

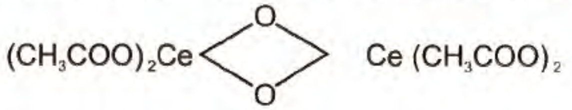
In the year 1957, this writer joined the Department of Chemistry, Ravenshaw College as a member of the teaching faculty. At the time, Dr. Dayanidhi Patnaik, Ph.D. (CANTAB) was recognised as an illustrious scientist for his contributions at the Cambridge University, (UK) that marked a new epoch in chemical kinetics[1,2]. He was an erudite scholar, an outstanding academic and a sagacious personality. I joined his school of research for my Ph.D. degree. During this period, his researches were mainly in the fields of chemical kinetics, ion-solvent interactions in mixed solvents and rare earth complexes. I was assigned with the problem to investigate on rare earths and uranium compounds. That was the period when research on nuclear materials was in vogue and widely pursued in various laboratories for the development of peaceful uses of atomic energy[3].

Cerium (IV) Acetates:

Before I could begin my investigations on uranium complexes, I was asked to study the thermal decomposition of ceric acetate, a new compound that was isolated a few months earlier[4]. Cerium (III) nitrate, $Ce(NO_3)_3 6H_2O$ when suspended in acetic anhydride, undergoes simultaneous decomposition and oxidation of cerium(III) to cerium (IV) giving an orange red solution which on being allowed to stand for several days in dark gives orange red crystals of anhydrous ceric acetate $Ce(CH_3COO)_4$. When ceric acetate was subjected to thermal decomposition at 65°C the dimeric mono-oxy hexa acetate

$$(CH_3COO)_3Ce \text{ ---- } O \text{ ---- } Ce(CH_3COO)_3$$

was obtained. The compound formed at 100°C was anhydrous ceric oxy-acetate



On exposure to moisture both the compounds undergo rapid reduction to cerous acetate[5].

Studies on Uranium (IV) Compounds:

Earlier researches on nuclear useful materials and uranium chemistry had attracted much attention. The investigations were primarily centred on the extraction of pure uranyl nitrate by solvent extraction using 25% tributyl phosphate (TBP) diluted with kerosene or hexane and preparation of uranium metal through successive transformations – (Scheme-1)

$$UO_{2(aq)}^{2+} + 2NO_{3(aq)}^{-} + 2TBP_{(org)}$$

$$\longrightarrow UO_2(NO_3)_2\ 2TBP_{(org)} \longrightarrow UO_2(NO_3)_2$$

$$\xrightarrow{\Delta} UO_3 \xrightarrow{\text{hydrogen reduction}} UO_2 \xrightarrow[\text{or Freon-12 (dry way process)}]{\text{fluorination with anhydrous HF}}$$

$$\xrightarrow[\text{Ca/Mg}]{\Delta} U.$$

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Uranium (IV) Formate:

The photolysis of uranyl oxalate, on account of its application in actinometry had been extensively investigated[6,7,8]. Our work was mainly focused on isolation of uranium (IV) compounds by photochemical reduction of UO_2^{2+} ion to uranium (IV) state using alcohol as a reductant and sunlight as the source of energy in presence of various anions or compounds and subsequent study of the properties of the products.

A mixture containing equal volumes of uranyl formate in water, formic acid and alcohol when exposed to sunlight, bright green crystals of aquo-oxyformate, $UO(HCOO)_2 1.5H_2O$ were formed. When the oxyformate was heated in vacuo at 160-170°C the anhydrous compound was obtained[9].

Uranium Dioxide:

Uranium dioxide is generally prepared by the reduction of UO_3 or U_3O_8 with hydrogen[10]. The thermal decomposition of uranium (IV) oxyformate in vacuo yielded uranium dioxide UO_2 as the product to the extent of 90%[11a,b].

Uranium (IV) Acetates:

Uranium (IV) oxyacetate was prepared by the photochemical reduction of uranyl acetate in a mixture of glacial acetic acid and alcohol. The compound obtained was a dirty green fine powder possessing the formula $UO(CH_3COO)_2$, H_2O. When this aquo oxyacetate was refluxed with acetic anyhydride the anhydrous uranium (IV) tetra acetate $U(CH_3COO)_4$ was obtained[12]. Thermal decomposition of uranium (IV) oxyacetate at about 450°C yielded the dioxide to the extent of 92%.

Uranium (IV) Sulphate:

An aquous solution of uranyl sulphate with formic acid and alcohol on exposure to sunlight undergoes photolysis when the bright green hydrated uranium (IV) oxysulphate $UOSO_4$, $3.3H_2O$ is precipitated. On heating the aquo oxysulphate at 150-160°C in vacuum for 3-4 hours the anhydrous compound was obtained[14 a,b]. Apart from simple oxysulphate, several double salts were photochemically isolated with Na_2SO_4, K_2SO_4 and $(NH_4)_2SO_4$.

Uranium (IV) Oxalates:

Application of uranyl oxalate in actinometry had been widely investigated. The uranyl ion UO_2^{2+} is reduced to uranium (IV) state with simultaneous oxidation of oxalic acid to CO, CO_2 and H_2O. Both U^{4+} and UO^{2+} represent the uranium (IV) state and it was evident that the former would give the oxalate $U(C_2O_4)_2$ while the latter the oxy-oxalate UOC_2O_4. The latter was not reported earlier. The oxalate compound was reported by Marchi[15] wherein the reduction was achieved in hot HCl solution by solid sodium thiosulphate. Buchi[16] had observed formic acid as one of the products of photolysis of uranyl oxalate. Yet no importance was attached to this observation as far as the role of formate ion in the photolysis is concerned. When we exposed a mixture of uranyl formate and oxalic acid in the ratio of 1:6 to sunlight for 8 - 9 hours, a dirty green precipitate was obtained. The compound was identified as hydrated uranium (IV) oxyoxalate having the formula UOC_2O_4, $6H_2O$[17].

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Uranium (IV) Fluorides:

Uranium tetrafluoride is generally prepared by the high temperature treatment of oxides of uranium with anhydrous HF[18] or freons[19, 20] and secondly by the action of HF[18,21] on the solution of uranium (IV) salts, the reduction of uranium (VI) to uranium (IV) state being brought about by the use of $SnCl_2$. Our investigation was to avoid high temperature treatment as well as the use of foreign substance in the preparation uranium tetrafluoride. In this method the uranium (IV) oxyformate prepared by the method of photolysis (loc.cit) as distinct from the method adopted by Rosenhein[22] formed the starting material. Thus the entire process of preparation of the tetrafluoride was confined to uranium, formic acid and hydrofluoric acid.

The hydrated uranium tetrafluoride $UF_4 1.5H_2O$ was obtained by the action of 30–40% HF on uranium (IV) oxyformate as an emerald green product.

This investigation was followed by direct photolytic method of preparation of uranium tetrafluoride. Of all common compounds of uranium, advantage was taken of the use of uranyl formate for the readiness with which it undergoes photolysis in presence of alcohol on exposure to bright sunlight giving uranium (IV) compounds (loc.cit). Thus when photolysis was carried out in aqueous hydrofluoric acid medium, the hydrated uranium tetrafluoride $UF_4 1.5H_2O$ was precipitated[23]. Use of uranyl nitrate also gave the same compound. When however, photolysis was carried out in presence of ammonium bifluoride in presence of hydrofluoric acid, $NH_4FUF_4H_2O$ was obtained[24]. The ammonium uranium (IV) fluoro complex described above, when heated in vacuo the monohydrate tetrafluoride was obtained.

The strong binding of the molecule of water to that of uranium tetrafluoride always leads to the formation of the hydrated compound $UF_4 H_2O$. When the hydrated product is heated in vacuo partial decomposition occurs as indicated by the appearance of black colour. But when hydrated tetrafluoride is treated with HF at high temperature, the partially decomposed product formed in the process of removal of water is simultaneously converted back to the tetrafluoride[25]. Preparation of anhydrous uranium tetrafluoride was achieved by heating an intimate mixture of anhydrous uranium tetraacetate and ammonium bifluoride NH_4F2HF, when the intermediate anhydrous complex NH_4FUF_4 was obtained. The thermal decomposition of the anhydrous complex in vacuum at about 450°C gave the anhydrous tetrafluoride[26].

Carbonates of Uranium (IV) and (VI):

Miller and co-workers[27] isolated uranyl carbonates prepared by the action of carbon dioxide under pressure on uranium trioxide, ammonium or sodium uranate. Cherneyev and co-workers[28] prepared the compound by the treatment of aqueous suspensions of uranium oxide UO_3 under normal conditions. A simple and convenient method was developed by us for the preparation of uranyl carbonate. When ammonium carbonate was added to photo chemically reduced solution then the unknown oxycarbonate $UO(CO_3)$, nH_2O was obtained as a green precipitate.

The tetravalent oxycarbonate on exposure to dry air underwent simultaneous oxidation and dehydration resulting in the formation of the compound UO_2CO_3, $2.5H_2O$, the process of oxidation being indicated by the gradual change of colour from dark green to bright yellow[29]. The hydrated uranyl carbonate when heated in vacuo at 160°C gave the anhydrous compound UO_2CO_3 which is stable upto 550°C.

Hydrazinium and Hydroxyl Ammonium Fluoro Complexes of Uranium (IV):

Hydrazine and hydroxyl amine evince powerful reducing properties and it became apparent that they could reduce UO_2^{2+} either photo chemically or thermally.

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$$2UO_2^{2+} + N_2H_4 + 4H^+ \longrightarrow 2U^{4+} + N_2 + 4H_2O$$

$$UO_2^{2+} + 2NH_2OH + 2H^+ \longrightarrow U^{4+} + N_2 + 4H_2O$$

There is a close similarity between the physical behaviour of hydrazine and hydroxyl amine and ammonium salts and one would expect that analogous hydrazine and hydroxyl amine fluoride complexes of uranium (IV) could be prepared. Investigations were, therefore, carried out to prepare hydrazine and hydroxyl amine complexes and to study their thermal decomposition with a view to prepare uranium tetrafluoride.

A solution containing uranyl nitrate, hydrofluoric acid and hydrazine on exposure to sunlight in presence of alcohol gave a bright green compound which on analysis was found to be anhydrous hydrazine uranium (IV) fluoride complex, $N_2H_5UF_5$.

Photolysis of uranyl nitratate in presence of hydroxyl amine in a similar manner gave the corresponding hydroxyl amine uranium (IV) fluoride complex $(NH_3OH)UF_5$[30].

The isomorphous hydrazinium thorium (IV) fluoride $N_2H_5ThF_5$ and hydroxyl ammonium thorium fluoride $(NH_3OH)ThF_5$ could be isolated by direct action of hydrazine/hydroxyl amine and hydrofluoric acid on thorium nitrate[31].

Powder pattern X-ray diffraction studies of hydrazinium and hydroxyl ammonium uranium (IV) fluoride complexes were studied by Ratho etal. These complexes were found to possess orthorhombic symmetry of space group Pmmm[32,33].

Hydrazinium Uranyl and Hydroxyl Ammonium Uranyl Fluoro Complexes:

Uranyl ion was known to form several coordination compounds with organic ammonium fluorides[34,35]. No uranyl fluoride compounds with hydrazine and hydroxyl amine had been reported. Since hydrazine and hydroxyl amines act as powerful reducing agents, their complexes with uranyl fluoride was undertaken. Subsequently, their thermal and photochemical decompositions were undertaken with a view to prepare uranium tetrafluoride.

When a mixture of uranyl nitatre and hydrazine hydrofluoride with a ratio 1:6 were subjected to crystallization a shining heavy yellow compound was found. On analysis the compound was found to possess the formula $UO_2F_2(N_2H_4HF)_3$, $1.5H_2O$.

When thermal decomposition of the compound was carried out in vacuo, the compound undergoes decomposition at about 200°C with simultaneous self reduction of uranium (VI) to uranium (IV) state and an emerald green compound was obtained as the product of decomposition. It was found to be hydrazine uranium (IV) fluoride monohydrate complex $UF_4N_2H_4HF, H_2O$.

On further heating the intermediate aquo hydrazine uranium (IV) fluoride complex, at about 400°C, uranium tetrafluoride was obtained in the anhydrous state as a bright green compound.

With a view to isolate hydrazine uranyl fluoride complexes of different compositions, crystallizations were carried out with varying quantities of uranyl nitrate and hydrazine hydrofluoride. Another complex possessing the formula $UO_2F_2N_2H_42HF$ $1.5H_2O$ was obtained after crystallization of a mixture of uranyl nitrate and hydrazine hydrofluoride in the molar ratio of 1:2.

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Anhydrous uranium tetrafluoride was directly obtained when this compound was heated in vacuo at about 400°C (loc. cit).

Two hydroxyl amine hydrofluoride complexes of uranium, $(NH_3OH)_3UO_2F_5$ and $(NH_3OH)UO_2F_3$ were prepared by slow crystallization of uranyl acetate, hydroxyl amine hydrofluoride in the molar ratio 1:8 and 1:2 respectively. Thermal decomposition of the compounds were carried out in vacuo at about 400°C. During heating simultaneous decomposition and reduction of uranium (VI) to uranium (IV) state occurred and UF_4 and a mixture of UF_4 and UO_2F_2 were obtained from $(NH_3OH)_3UO_2F_5$ and $(NH_3OH)UO_2F_3$ respectively[37].

The complexes of hydrazine uranyl fluorides $(N_2H_5)_3UO_2F_5$, $1.5H_2O$ and $(N_2H_6)UO_2F_4$ $1.25H_2O$ were found to be light sensitive and their aqueous solutions underwent photo decomposition with simultaneous reduction of uranium (VI) to uranium (IV) state and yielded emerald green crystalline $UF_4N_2H_4HF$ and UF_4H_2O respectively. In a solid state the photo reduction remained incomplete on prolonged exposure to light for several days[38].

Fluoro Complexes of Uranium (IV) with Organic Bases:

Fluoro complexes of uranium (IV) with organic bases had received scant attention, although a number of uranyl fluoride complexes had been reported by Olson[39]. There had been considerable number of reports on the synthesis and characterization of a number of Chloro, Bromo, iodo and nitrato complexes[40-43].

We attempted the preparation of a number of fluoro complexes of uranium (IV) with organic bases such as ethyl amine, iso-butyl amine, ethylene diamine, propylene diamine, benzyl amine, aniline, α and β napthyl amine, pyridine, picolines and quinoline employing photolytic method. As usual sunlight was used as the source of energy for photolysis and alcohol or formic acid was used as a reductant since they offered the advantage because they, being volatile, could be easily removed from the final product and were therefore, less likely to introduce impurities. The ethylene diamine, propylene diamine and γ-picoline uranium (IV) fluoro complexes possessed the formula $(C_2H_4N_2H_6)UF_6$, $(C_3H_6N_2H_6)$ UF_6 and γ-picoline $(C_6H_7NH)_2UF_6$ respectively while the rest had the composition $(org.arm)^+UF_5nH_2O$[38].

Apart from analytical methods, infrared absorption spectra of the fluoro complexes was used to identify the nature of protonated amine groups. IR spectra was taken using Perkin-Elmar 221 spectrometer in potassium bromide phase. The spectra of the complexes resembled the characteristic spectral patterns of amine hydrohalides as observed by earlier workers[44-49].

In case of primary amine salts the most distinguishable features of the spectra are the $N---H^+---X$ stretching frequencies giving a strong and broad band near 3000 cm^{-1} which partially coincided with CH_3 or CH_2 stretching bands. Besides there are two or three bands above NH_2^+ stretching bands near 3200 cm^{-1}. They have been assigned to the first overtones of the deformation vibrations located in the region 1600-1500 cm^{-1} or a combination of them.

The NH^+ stretching vibrations of aromatic amine hydrohalides possess similar features. The two bands in aniline hydrochloride have their maximum at 2810 and 2570 cm^{-1}. The high frequency band which is strong as well as broad has been attributed to contain two or three NH_3^+ stretching frequencies.

The NH^+ stretching bands for pyridine, picolines and quinolines were observed in the region 2700 to 2600 cm^{-1} indicating the general formula of the compound to be $[RH^+]$ $[UF_5]$ where R represents either an amine or a pyridine group.

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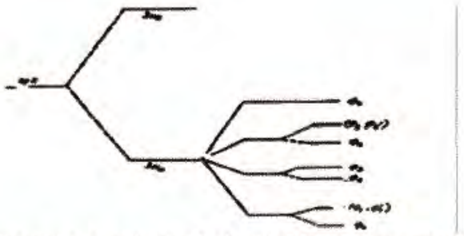
Magnetic Susceptibility of Uranium (IV) Complexes at Lower Temperatures:

The magnetic properties of actinide group of elements had received limited attention. The fine details of the magnetic properties of rare earths and iron group of elements were well worked out. In the actinides, the basic confusion arose with the ground state configuration of the magnetic electrons. Dawson[50] reviewed the magnetic susceptibility data of some of the actinide complexes and concluded that for ions with one or two electrons the 6d rather than 5f shell electrons are important magnetic ions. His suggestion was based on the fact that many of the ions of the actinide group of compounds indicate spin only moments in a way analogous to iron group compounds. However, Hutchison and Candela[51] indicated that the magnetic electrons in the 5f shell in crystalline environment can also give rise to effective spin only value of magnetic moment. This was confirmed from the optical absorption studies which showed similarities in the absorption spectra with rare earth salts in which the magnetic electrons are in the 4f shell[52].

Magnetic properties of three fluoro complexes of uranium (IV), namely ammonium uranium (IV) fluoride NH_4UF_5, hydrazinium uranium (IV) fluoride $N_2H_5UF_5$ and hydroxyl ammonium uranium (IV) fluoride $(NH_3OH)UF_5$ were studied with the object to investigate the nature of symmetry of the crystalline field and their influence on magnetic properties of UF_4 complexes.

Temperature variation susceptibility of the complexes were measured by Faraday Technique in the temperature range 353.0 K to 127.0 K . The square of effective moment Pe^2 = 8.00 xmT was plotted against the absolute temperature. The results were explained on the basis of the theoretical diagram shown in figure-1



Free ion + Spin orbit coupling + Cubic field + Tetragonal field

Figure-1 : Energy level ×diagram for U^{4+} ion in a cubic co-ordination

The most important feature of the present experimental result[53] is that in UF_4 complexes a non-magnetic singlet is the lowest and at about 200 cm^{-1} a degenerate doublet contribute most of the susceptibilities at high temperature. Such an energy spectrum evidently leads to a large temperature dependence of magnetic moment. The g value is nearly isotopic at room temperature. The intensity of the resonance line is expected to diminish appreciably with the lowering of temperature.

II

Separation of Uranium from Associated Elements

Separation of Uranium from Aluminium, Thorium and Cerium:

Photolytic process of isolation of the hydrated complex, $NH_4FUF_4H_2O$ has been applied for the separation of uranium from aluminium and a mixture of thorium, cerium and lanthanum. The waste products of reactors contain about 95% of unconsumed uranium along with aluminium from which the former is separated by solvent extraction process[54]. A convenient photolytic method was developed by us

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when ammonium bifluoride is added to an aqueous solution of nitrates of uranium and aluminium, a considerable portion of the latter is precipitated as fluoride which was filtered off. The filtrate with 10% alcohol on exposure to sunlight undergoes photolysis and pure uranium is precipitated as the hydrated fluoride complex and the recovery was to the extent of 99%.

Following this work a series of experiments were carried out for photolytic separation of uranium from several other associated elements. The separation of uranium from vanadium was carried out by photolysis in sunlight. For the purpose, solution mixtures of uranyl sulphates and vanadyl sulphates or ammonium vanadate containing formic acid and ethanol were exposed to sunlight. Pure uranium was precipitated in the form of hydrated oxysulphate leaving vanadium in solution. The influence of H^+ ion concentration, time period of exposure and the percentage composition of ethanol on the recovery was investigated. Separation of uranium to an extent of 95% could be achieved[56].

Photolytic separation of uranium from thorium, zirconium and manganese was carried out in the pH range 2.1 to 2.3 adopting a similar procedure stated above. The effect of variation of the alcoholic composition on the purity and recovery of the uranium was investigated under a variety of conditions. 92% of uranium was recovered and 96.5% purity was achieved when alcohol was 30%[57].

Use of ammonium uranium (IV) fluoride complex for the separation of uranium has been stated above (loc.sit). The same photolytic method for separation of uranium from beryllium and zirconium was used. In the pH range 2.0 to 3.0; about 95% uranium could be recovered[58].

Epilogue

Dr. Dayanidhi Patnaik was a towering intellectual. During the period of our intimate association with him, all the scholars have enjoyed his scintillating talks in many evenings. His views on scientific, academic, social, cultural, political and economic issues were clear and unequivocal. During these years, his scientific output has been prodigious.

He had a momentous student life when in the school (1930-31) at his birth place Dhenkanal. He supported the Civil-disobedience Movement, Salt Satyagraha and Dandi March led by Mahatma Gandhi. He must have then realised the deep inspiration he had for the freedom of the people of India. For his patriotic spirit, he was forced to leave the Princely State of Dhenkanal over night and moved to continue his studies at the P.M. Academy, Cuttack.

Towards the end of 1961, his interest turned away from science when he devoted a good deal of his time in profoundly thinking of social problems of the country, particularly on the Sarvodaya Movement of Vinoba Bhave. His life was surely taking a new direction. He was waiting for the inner voice. Actions reflect the strength of the voice. In 1963, he emerged into the public arena and dedicated himself for the service of the poor. He joined Acharya Vinoba Bhave's Sarvodaya Movement. His impact on his new Odyssey has been nothing short of extraordinary. He was accorded the signal honour of 'Bhoodan Dr.' by Vinobaji for his dedication in the cause of the poor. In today's self-oriented chaotic world, such selfless service is a hope for the future of the humanity.

He lived upto the age of 67 and died in the year 1985. His ideals still reverberate in the hearts of his students and like a sparkling stream his legacy is continuing.

This author owes a deep sense of veneration for the love, affection and inspiration he has received from him. This humble piece of work penned by this author is dedicated to his memory on this solemn occasion of his birth centenary.

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Legacy of Professor Dayanidhi Patnaik

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(Former Ph.D Scholars of Prof. Balaram Sahoo at IIT-Kharagpur)

Professor Dayanidhi Patnaik an eminent scientist of India is noted for his research in photochemistry, the study of effect of light on chemical reactions. He began his research on photochemical studies at the Cambridge University in 1948 and recognized some short lived intermediates in chemical reactions. In a subsequent and extended investigations Professor Norrish and Porter used short pulses of light energy in studying chemical reactions and were awarded Nobel prize in 1967.

In Ravenshaw College he extended photochemical studies for the preparation of important chemical compounds of cerium, vanadium and uranium. The school of research established has vastly expanded and diversified by subsequent generations of scholars. Their contributions to chemistry have become phenomenal and each such school has become a pillar for the advancement of chemistry.

The authors of the present article were associated with the school of research of Professor B.Sahoo who worked under the inspiring guidance of Professor Patnaik, we briefly present here on some of our achievements on transition metal polynuclear complexes, encapsulation and macrocyclic complexes.

Section – A: Transition Metal Polynuclear Complexes:

Studies on polynuclear complexes were an attractive area of investigation by inorganic chemists during the second half of the 20th century. The reasons for this interest were the fundamental importance in exchange interactions, with theory of bonding and new magnetic materials research.

The metal chelates which had been studied involved the coordination of various donor atoms of the polydentate chelating agents towards a single metal ion. Discovering chelating agents which either form chelate rings with two metal ions or span towards two metal ions on coordination yielding bi or polynuclear complexes was in an embryonic state.

A small group of such chelating agents which coordinate with two or more metal ions producing bi or polynuclear metal chelates were tetrafunctional azines such as pyridine aldazine, 2-pyridyl methyl ketaxine, dihydrazine - diacetyl azine whose metal complexes were studied during this period[1,2,3]. From conductivity, magnetic and spectral evidence, valuable information had been obtained with regard to their stereochemistry and structures. In general, the tetrafunctional azine ligands were found to act as bi-bidentate ligands with each of the –N==N-- group coordinated to one of the two metal ions. They were further found to function as bidentate and tridentate ligands in certain specific cases[4a,4b]. Our predecessors in the lab were actively engaged to isolate polynuclear transition metal

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complexes with new organic ligands that possessed appropriate structural features. A short account of these works is described here:-

Salicylaldazinato Metal Chelates and their Structural Studies:

Salicylaldazinate ($C_{14}H_{10}N_2O_2$, SAA) metal complexes with Cu^{2+}, Ni^{2+} and Co^{2+} were reported by Marvel and Bonsignore[6], but no structural investigation of these complexes was provided. Sahoo and Satapathy considered it to be of interest on account of certain stereochemical factors involved with Salicylaldazine ($SAAH_2$). Because of high degree of conjugation the ligand was expected to be coplanar and therefore coordination should be restricted to a plane along the edge of the molecule. Availability of 4 coordinate sites and azine group would render the ligand to act in a tetrafunctional manner and the ligand is likely to coordinate in a bi-bidentate manner to each of the metal ion. Besides it might act as a tridentate chelating agent in order to utilize both the oxygen atoms and one of the nitrogen atoms of the azine group. The latter configuration would give rise to dissimilar a 6 and a 7 membered chelate rings respectively. Satapathy and Sahoo investigated the syntheses of Cu(II), Ni(II), Co(II), and Fe(II) complexes of Salicylaldazinate and studied their infrared spectra, electronic spectra and magnetic behaviour in order to get information on the structures of the complexes.

Analytical results suggested that Cu(II), Ni(II) and Co(II) had the formula M(SAA) or $M_2(SAA)_2$ and Fe(II) had the composition $Fe_2(SAA)_2(H_2O)_6$.

I.R. spectra showed the vibrational bands of the ligand changed significantly on coordination. There were minor differences between the I.R. spectra of Cu(II), Ni(II) and Co(II) but I.R. spectra of Fe(II) complex significantly differed from the above complexes clearly reflecting on the metal ligand bonding in two different ways.

On coordination of the ligand of Cu(II), Ni(II) and Co(II), the C=N band of $SAAH_2$ at 1,623 cm^{-1} shifted towards a lower frequency region which suggested that the metal-ligand π electron interaction in the newly formed chelate rings. On the other hand, two C=N bands were observed in the Fe(II) complexes and their locations were near 1,613 cm^{-1} and 1,595 cm^{-1}.

The next important absorption bands in the ligand were found at 1,266 cm^{-1} and it was attributed to C—O stretching vibrations. In the metal complexes of Cu(II), Ni(II) and Co(II) this band shifts to 1,300 cm^{-1}. In the iron complex the most noticeable feature of this spectra in this region was the appearance of 2 C--O bands at 1,300 cm^{-1} and 1,272 cm^{-1} respectively. The I.R. spectra for Cu(II), Ni(II) and Co(II) were unambiguous and point to the structure shown in Fig-1(a,b).

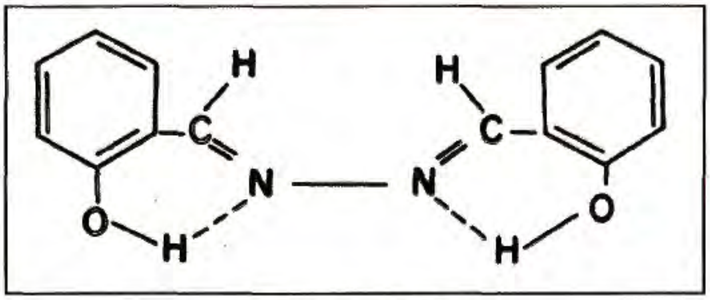

Figure - 1(a)

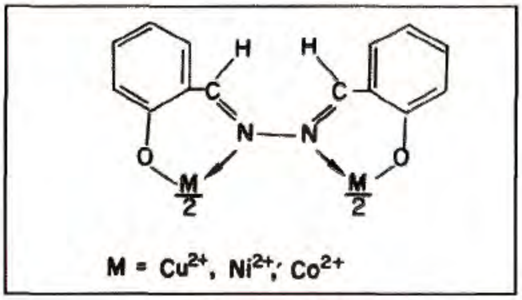

Figure - 1(b)

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The vibrational bands of C=N, C=O and phenyl rings in the iron complex were split suggesting the presence of dissimilar chelate rings and therefore the compound was postulated to possess the structure a s shown in Fig-2.

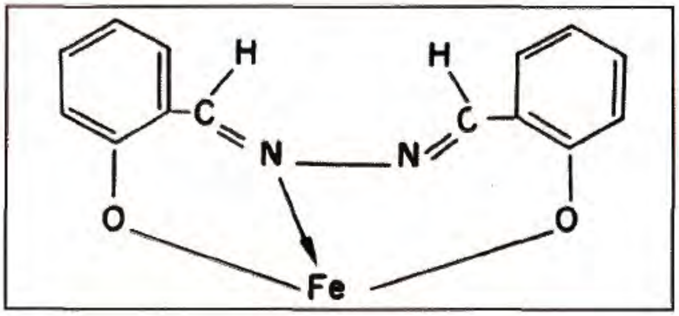

Figure - 2

The reflectance spectra of Cu(II)SAA complex consist of two ligand field bands of approximately equal intensity at 14,000 and 15,000 cm^{-1} which supported tetrafunctional coordination of Cu(II) in an essentially planar environment.

The diffuse reflectance spectra of NiSAA complex show bands at 10,600; 17,500; and 23,800 cm^{-1} and shoulder at 26,000 cm^{-1}. The position and number of bands implied that the nickel ion is present in a symmetry lower than octahedral environment. The first two bands broadly correspond to the transitions

$$3T_{2g} \longleftarrow 3A_{2g} \quad 10{,}600\ cm^{-1}$$

$$3T_{1g} \longleftarrow 3A_{2g} \quad 17{,}500\ cm^{-1}$$

The 3rd band is clearly split into two components at 23,800 and 26,000 cm^{-1} respectively.

The magnetic moment of Co(II) complex 4.40 B.M. at room temperature implies three unpaired electrons. It shows considerable orbital contribution to the magnetic moment. The electronic spectra showed the first band at 9,000 cm^{-1} and a broad band in the region 20,000 to 25,000 cm^{-1}. The position of the bands ruled out tetrahedral coordination and resembles spin-free quadricoordinated Co(II) in a planar or a nearly planar environment.

The reflectance spectra of bis-salicylaldazinato Fe(II) complex showed a broad band at 11,700 cm^{-1}. This band was assigned to spin allowed transition $^5E_g \longleftarrow {}^5T_{2g}$. The band further shows sign of a double structure with a peak separation of 500 cm^{-1} towards lower frequency region.

Magnetic Properties:

Magnetic properties of salicylaldazinato complexes of Cu(II), Ni(II), Co(II) and Fe(II) were measured over the temperature range 106 to 305 K. The resultant susceptibility (χm) were corrected for diamagnetism and temperature independent paramagnetism. The effective magnetic moments μ_{eff}, were calculated at each temperature, employing the expression $\mu_{eff} = 2.83\ (\chi mT)^{1/2}$. Graphs of $1/\chi m$ against temperature gave straight lines and yielded negative values for the Weiss constant for Cu(II), -22 K, Ni(II), -75 K, and Co(II) -15 K, indicating weak antiferromagnetic interactions and satisfactorily explained the structure of the complexes shown in Fig- 1 & 2.

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The magnetic moment expected for Fe(II) octahedral complexes is 5.5 B.M. at 300 K and 5.1 B.M. for tetrahedral coordination. The planar phthalocyanine complex shows a moment 3.96 B.M. at 293 K[7,8,9].

The magnetic moment for Fe(II) SAAH complex at room temperature was appreciably below the spin-only moment (4.26 B.M.) and the moment further falls as the temperature was lowered and attained a value of 3.76 B.M. at 118 K. The Weiss constant was found to be -112 K. The magnetic data could not be explained based on the earlier structure suggested at Fig-2. A modified structure was suggested by Satapathy and Sahoo on the basis of antiferromagnetic interactions between pairs of Fe(II) ions; spin transmission occurring through bridging O--H groups as shown in Fig-3.

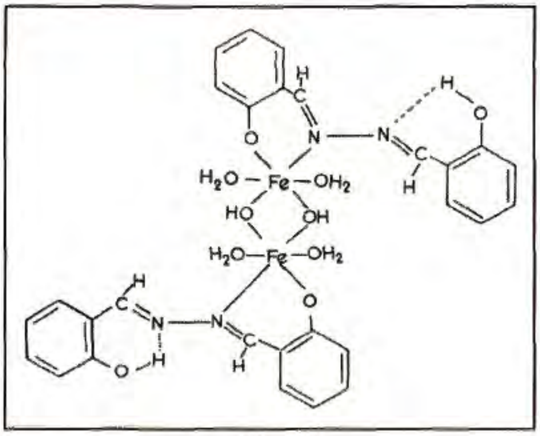

Fig - 3

Complexes of Diacetylazine Dioxime:

The synthesis of the ligand diacetylazine dioxime (abbreviated as $DAADOH_2$) and its metal complexes with a variety of divalent and trivalent metal ions were next investigated[10,11].

Two types of complexes possessing stoichiometry, M(DAADO),nH_2O [n=0 for Cu(II), Co(II), Pd(II) and Pt(II), n=2 for Ni(II)] and Fe(II)] and $M(DAADO)_{1.5}$ for trivalent iron were obtained as inner complex salts. Structures of the complexes were proposed on the basis of infrared, electronic spectral and magnetic property measurements.

Infrared spectra of the ligand showed multiple bands in the region 3,300 to 2,700 cm^{-1} indicating strong hydrogen bonding involving NOH groups. A sharp band at 1,672 cm^{-1} has been assigned to O--H deformation mode of vibration of NOH groups. Spectacularly these bands do not appear in the metal complexes where O—H bond has been broken in the formation of the complexes.

The spectra of the ligand as well as the metal complexes have certain features in the region 1,600 to 900 cm^{-1} which are particularly useful as evidence of structure. The first band in this region in the ligand and its metal complexes is found in the region 1,600 to 1,560 cm^{-1}; this has been attributed to the C = N stretching band.

The N – O stretching band for the oximes appear in the region 960 to 930 cm^{-1}. In the $DAADOH_2$ and its metal complexes it appears in the region 980 to 930 cm^{-1}. The most important features of this spectra in the ligand and the metal complexes, there was one to one correspondence for all the bands.

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The bands for C = N and N -- O groups do not split. Metal nitrogen bands appear in the region 650 to 600 cm^{-1}. The I.R. spectra unequivocally pointed to the binuclear structures for all the complexes as represented in Fig – 4 (a,b).

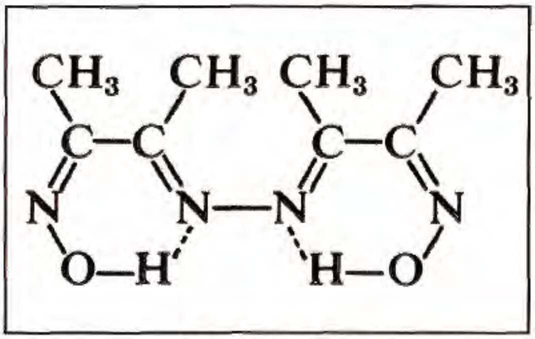

Figure - 4(a)

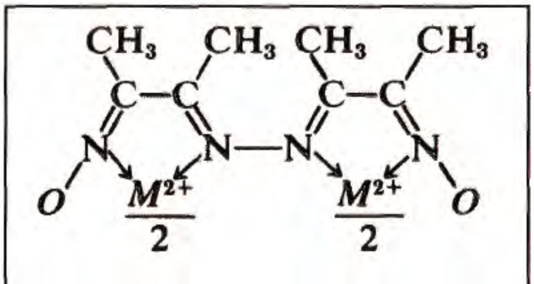

Figure - 4(b)

Electronics spectra of diacetylazine dioxine show an intense band at 27,700 cm^{-1} which is believed to arise due to $\pi^* \longleftarrow \pi$ transition.

The diffused reflectance spectra of diacetylazinedioxine Cu(II) complex reveals a broad band at 15,000 cm^{-1}. The broad band which shows considerable structure represents two or three superposed absorptions and is comparable both in position and width with earlier reported planar Cu(II) complexes and led them to propose tetracoordinated planar structures for the Cu(II) complex.

The diacetylazinedioximato Ni(II) complex is paramagnetic and shows bands at 17,000 cm^{-1} and 26,000 cm^{-1}. In an octahedral approximation these bands were ascribed to the transitions

$$^3T_{2g}(F) \longleftarrow {}^3A_{2g} \qquad 17{,}000\ cm^{-1}$$

$$T_{1g}(P)\ {}^3 \longleftarrow A_{2g} \qquad 26{,}000\ cm^{-1}$$

respectively. A third band is found at 29,000 cm^{-1} which arises due to charge transfer or intra-ligand transitions.

Magnetic Properties:

Magnetic properties of Cu(II) and Ni(II) has been extensively investigated[12-15]. The magnetic properties of diacetylazinedioximato complexes were investigated over the temperature range 90 to 300 K. The plot of 1/ χm against temperature gave straight lines for both the complexes and both yielded negative values of the Weiss constant -160 K and -75 K respectively. The magnetic data suggested antiferromagnetic interaction between metal centers and the magnetic exchange interaction is most probably intramolecular, the exchange occurring through the π electron system.

It was interesting to observe that the binuclear diacetylazinedioximato Mn(II) complex possesses magnetic moment 3.57 B.M. at room temperature[7]. The value is appreciably below for five unpaired electrons but close to the spin-only moment for three unpaired electrons, (3.87 B.M.) and explained that the Mn(II) ion was in a square planar environment and possessed the orbitally non-degenerate $(b_{2g})^2$ <

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$(eg)^2 < (a_{1g})^1$ electronic configuaration with three unpaired electrons Fig-5. The ligand field strength of diacetylazinedioximato Mn(II) complex appears to be comparable to phthalocyanine.

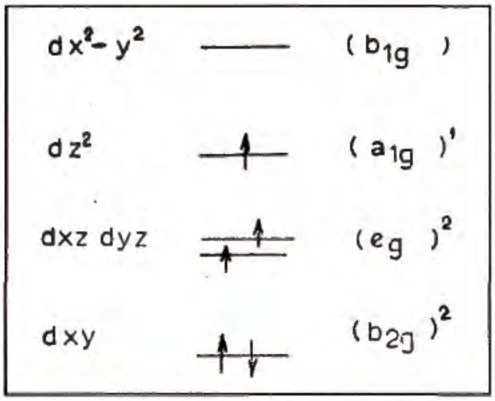

Figure - 5

Mn(II) phthalocyanine complex is another rare complex of Mn(II) whose magnetic moment corresponds to three unpaired electrons[16,17]. However, in sharp contrast to Mn(II) phthalocyanine, the moment of diacetylazinedioxymato Mn(II) falls with lowering of temperature and attains a value 2.75 B.M. at 80 K which characterizes antiferromagntic interactions between pairs of Mn(II) ions within the complex salt.

Dimethylglyoximato Copper (II) Complexes:

When these investigations were in progress in our lab, some contemporaneous publications appeared that showed the emergence of trinuclear complexes[18,19,20]. Dimethylglyoximate Ni(II) was the first compound used for analytical works and was discovered 14 to 15 decades ago. Traditionally it was believed to form mononuclear complexes, acting as a bidentate ligand involving coordination through its nitrogen atoms. A new journey began in 1972-74 when it was realized by our school that it can act as a tridentate ligand to give homo and hetero trinuclear complexes that would involve coordination of both nitrogen and oxygen atoms towards two adjacent atoms.

Trinuclear dimethylglyoximate Cu(II) of the type $Cu_3(DMG)_2X_4$, nH_2O (X=Cl, n=0, X=Br, n=4) were obtained by the action of the corresponding salt with $Cu(DMG)_2$ Fig - 6. On the other hand a strikingly different complex $Cu(DMG)_2[(CuNO_3)_2]$ was obtained when Cu(II) nitrate was added to $Cu(DMG)_2$ (Fig - 7)[21].

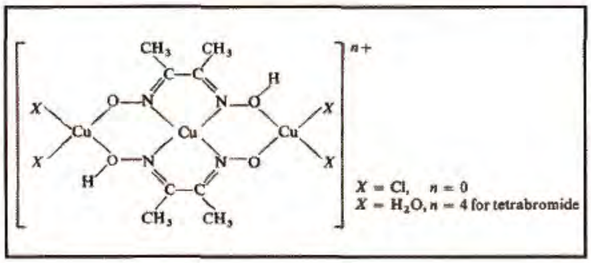

Figure - 6

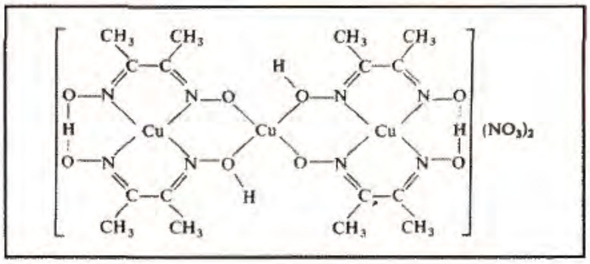

Figure - 7

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Structures were assigned on the basis of infrared and electronic spectral data. Magnetic measurements over the temperature range 305 to 80 K showed strong antiferromagnetic interactions between metal centers The J, exchange integrals and g values were estimated for each compound and are as follows;

	J	g
$Cu(DMG)_2CuCl_4$	-91	2.05
$Cu(DMG)_2[(Cu(NO_3)_2]_2$	-175	2.06

A decade later a hetero binuclear complex was reported Fig – 8.[22]

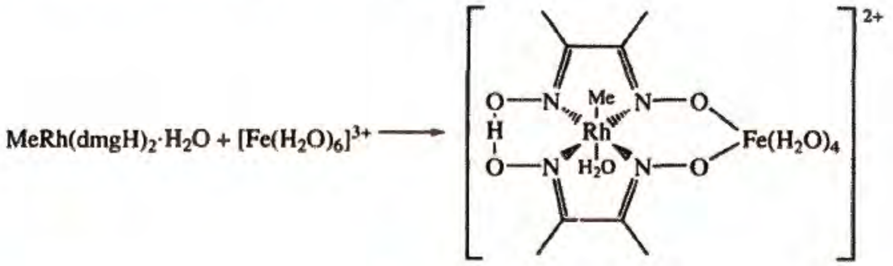

Figure - 8

3, 5 - Dimethyl Pyrazolato Metal Complexes

Metal complexes of pyrazole and its derivatives particularly 3-methylpyrazole and 3, 5 dimethylpyrazole had received considerable attention[23,24]. All available structural information showed that the ligands acted as unidentate ligands. Under suitable conditions their anions could be prepared and respective metal complexes could be isolated. The anions might be potentially capable of coordination towards two metal ions at the accessible – N – N – bridging site Fig-9[25]

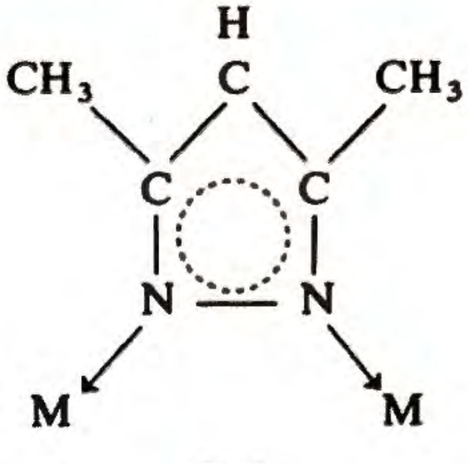

Fig-9

and thus can trap 2 metal ions in fairly close proximity with each other. As a matter of fact two complexes of the type $[Co(II)Pz)_2]_n$, $[Ni(II)(PZ)_2.2H_2O]_n$ and $[Cu(I)PZ]_n$ were isolated by the action of hydrazine on the corresponding acetylacetonato metal complexes. Structures were established on the basis of i.r. data and spectral data.

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Magnetic properties of Ni(II) and Co(II) complexes were interesting. The magnetic moment of Ni(II) complex was 3.20 B.M. which was independent of temperature (103 to 303 K). The results of the measurement of susceptibility were clearly consistent with an octahedral stereochemistry about the metal ion with $3A_{2g}$ ground state and no magnetic exchange occurs between the nickel ions.

Strikingly the Co(II) complex exhibited temperature dependance of its moments. The magnetic moment was 4.40 B.M. at 303 K and fell gradually with lowering of temperature and attained a value of 3.68 B.M. at 103 K. The Weiss constant was found to be -56 K. Regular tetrahedral complexes have moments in the range 4.40 to 4.80 B.M. Pseudo-tertrahedral Co(II) complexes have moments 4.5 to 4.82 B.M. with little or no temperature dependance[26,27]. The magnetic data of 3, 5 pyrazolato Co(II) suggest antiferromagnetic exchange intra molecular interaction between Co(II) ions and provide further evidence of polynuclear nature of the complex. Temperature dependance of moment for interacting tetrahedral Co(II) complexes do not appear to have been known earlier. Magnetic properties of a few Co(II) complexes with phthalazine and pyrazine which act as bi-bidentate ligands were reported a few months earlier by Lever and co-workers[28]. These complexes appeared to be the first such tetrahedral Co(II) complexes where spin-spin interactions between Co(II) ions exists.

Metal Complexes of Polyketones

Several metal chelates with a variety of triketones and structurally related ligands with Cu(II), Ni(II) and Co(II) were reported during this period[29-33]. We designed and synthesized a novel series of hexaketones where two groups of triketones were linked to one another through an aromatic ring.

A series of three structurally potential β-polyketones namely m/p–bis–(1,3,5 -trioxohexyl) benzene, (m/p THB) and m-bis-(1,3,5-trioxo - 5 phenyl pentyl) benzene (TPPB) which can span towards two or more metal ions to yield poly-metal complexes were synthesized. Each of these molecules in its enol form contains a 12 π electron system delocalized over the entire molecule rendering it to possess a planar structure. Stereo chemical considerations precluded the possibilities of the coordination of the triads of oxygen atoms towards a single metal ion. On the whole the entire ligand molecule can coordinate towards four metal ions containing two pairs of metal ions in bi-binuclear form and each metal ion within a pair being bridged through a common oxygen atom.

From the important features of the infrared spectra, the mode of bonding of the ligands of the metal complexes were postulated as shown in Fig – 10 a, b.

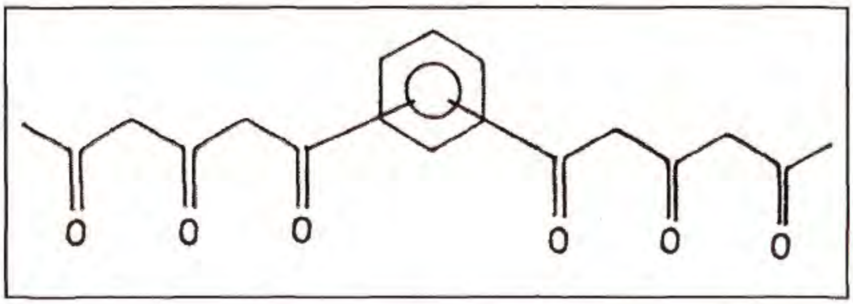

Figure - 10 a

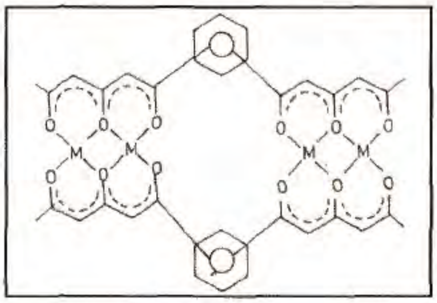

Figure - 10 b

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The orthophenylene diamine Schiff base complexes of Cu(II), Ni(II) possessed the formula M_4L_1 nH_2O (n=0 for Cu, n=4 for Ni(II)) Fig- 11. It was striking that no band was observed in the region 3,300 to 3,200 cm^{-1} which could be attributed to NH_2 stretching vibrations suggesting condensation of both NH_2 groups of orthophenylene diamine with metal hexa ketones.

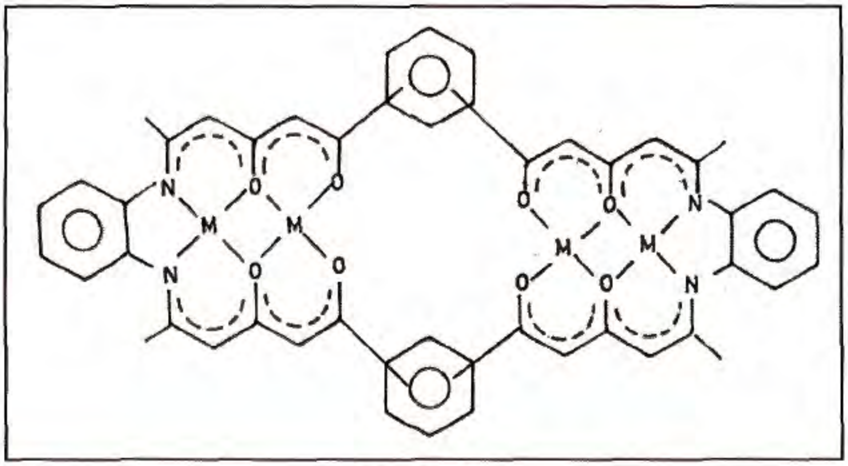

Figure – 11

In the region 1,600 to 1,400 cm^{-1} all the molecules show multiplet band structure. Two of these bands are intense and occur at 1,600 and 1,550cm^{-1} respectively which from their intensity and sharpness considerations have been attributed to C — O and C — N stretching vibrations respectively, partly overlapping on phenyl ring vibrations.

From these results a macrocyclic ring structure for the metal complexes were proposed where Cu(II) complexes are four coordinated planar having the chromophores CuO_4 and CuN_2O_2; the Ni(II) ions occur in different ligand fields, one in octahedral chromophore NiO_6, with two additional oxygen donor atoms coming from water molecules and another planar with the chromphore NiN_2O_2 the central Ni(II) ions are spin-free octahedral whereas the terminal Ni(II) ions are spin paired.

The structure of the oximato complexes consist of four metal ions; two of the terminal metal ions are coordinated with oxime emine nitrogens and share two common oxygen atoms with inner metal ions, while the other two metal ions are coordinated to the ketonic oxygen atoms. The hexa coordination of Ni(II) ions are satisfied with additional coordination of water Fig - 12.

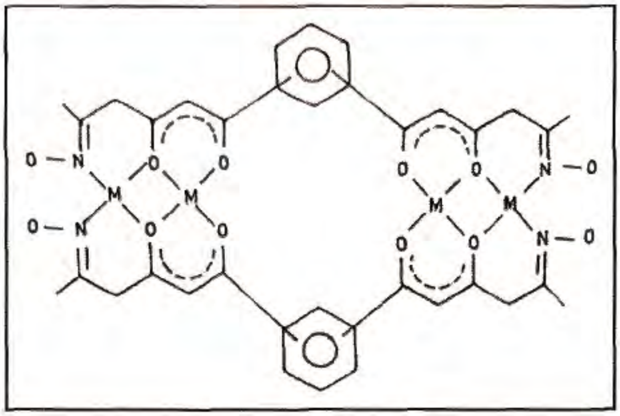

Figure - 12

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Magnetic susceptibilities of the complexes have been measured from ambient to 80 K and results have been discussed in terms of Heisenberg-Dirac-Van Vleck coupling Hamiltonian. The best fit values for the exchange coupling constant J and Lande' splitting factor g have been determined for each compound.

The J values for the hexa ketanato and microcyclic complexes of Cu(II) are negative and characterize antiferromagnetic interactions. The Ni(II) complexes also possess negative J values and are antiferromagnetic complexes. On the other hand the macrocyclic complexes where Ni(II) ions occur in mixed spin states that is with triplet and singlet ground terms in equal mole proportions and show magnetic moments independent of temperature.

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Section – B: Encapsulated and Fluoro-Borobridged Macrocyclic Complexes:

Studies on macrocyclic complexes have become an exciting subject of research and have grown phenomenologically during the past five decades. Interest in investigations have been rejuvenated due to unravelling of the facts that the basic structural units of a number of naturally occurring systems such as chlorophyll, haemoglobin and vitamin B12 contain porphin and related macrocyclic rings (Figure-1) bonded to Mg(II), Fe(II) and Co(II) ions. These fascinating molecules occupy crowning position in biological evolution and sustenance of life on earth. Newly discovered synthetic macrocycles, their structural elucidation and reactivities have greatly enhanced our understanding on the role of metal ions in the intricate physic-chemical processes occurring in biological systems. Besides, macrocyclic complexes have found applications in diverse areas like catalysis, photochemistry, energy harvest, semiconductor materials, drugs and dye stuffs.

Work on synthetic macrocycles began in 1884 when von Bayer reported the first synthetic macrocycle formed by the reaction of pyrrole with dry acetone in presence of hydrochloric acid. Its oxygen analogue was isolated about eight decades later by Ackman and co-workers by proton catalyzed condensation of furan with acetone [Figure-1(a-e)].

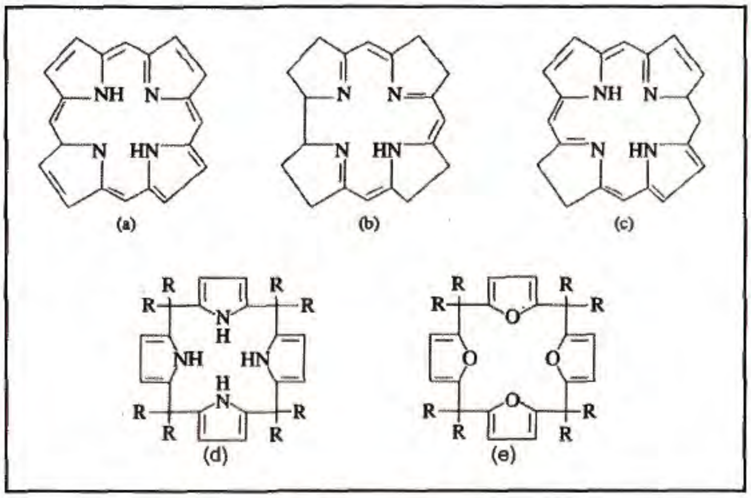

Figure - 1(a-e)

In 1934, metal phthalocyanines (Figure-2) were discovered and attracted attention for their industrial applications, catalytic activity for syntheses of unusual organic compounds and for their semiconductor behaviour.

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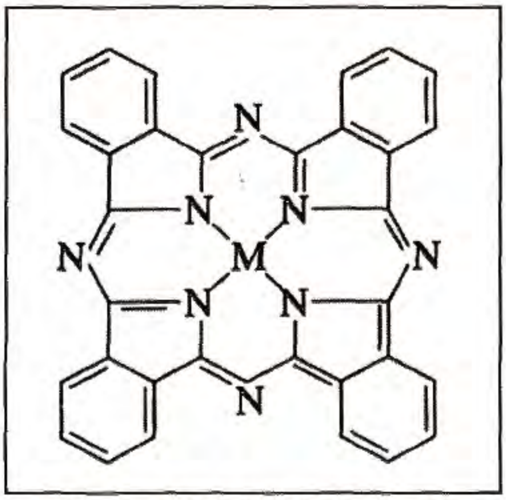

Figure - 2 Metal Phthalocyanine

Progress in syntheses of macrcycles was hindered for a long period for want of standard procedures. For a high degree of molecular reorganization is essential for effective macrocyclization. Besides, endeavours for the most part were unsuccessful due to associated problems such as low yields, polymerization during the reaction process and generation of side products.

1n 1960, Curtis reported the synthetic macrocycle $Me_6[14]4$, 11-diene N_4 (Figure-3) formed by the action of dry acetone on tris(ethylenediamine) Ni(II) perchlorate and isolated the two isomeric forms shown in Figure-3 (a) and (b). This momentous work led to the development of general methods of approach to synthesize new azamacrocycles and encouraged their multifaceted growth.

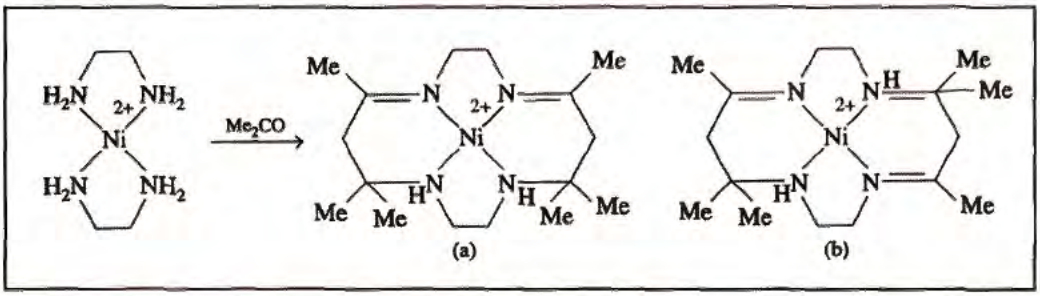

Figure - 3

Within a couple of years, Schrauzer and co-workers isolated the fluoroboro-bridged macrocycle (Figure-4) by treating boron trifluoride with dimethylglyoximato Ni(II).

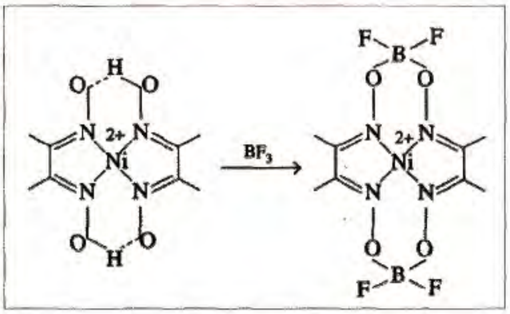

Figure - 4

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There was a dramatic development in 1967 when Pederson reported a new class of cyclic polyethers and christened them as 'crown ethers'. Since then there has been conscious and indomitable efforts that spurred the growth of macrocyclic chemistry and it has developed along two principal lines namely, crown ethers and azamacrocycles.

Crown Ethers and Cryptands

Structures shown in Figure-5 (a), (b) and (c) represent some typical examples of cyclopolyethers. These crown ethers have the remarkable property to form complexes with alkali and alkaline earth metal ions so far treated as 'Cinderellas' in the realm of coordination chemistry. Pederson baptized these molecules as 'crowns' not for their geometrical shapes as is generally believed but for the fact that 'they crown the metal ions even as a regal crown adorns the brow of the monarch'.

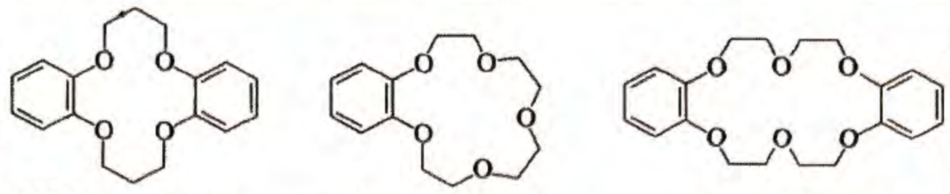
(a) Dibenzo-14 crown-4 (b) Benzo-15-crown-5 (c) Dibenzo-18-crown-6

Figure - 5

Soon after the discovery of crown ethers a new group of macrocycles of the type (Figure-6) known as azacrowns were synthesized. Another extraordinary group of compounds were introduced by Lehn and co-workers and are known as cryptands. They are macro bi-, tri-, or poly-cyclic compounds and are notable for their ability to entomb metal ions within their cavity. A few examples of cryptands with nitrogen bridgeheads are shown in Figure-6 (a), (b).

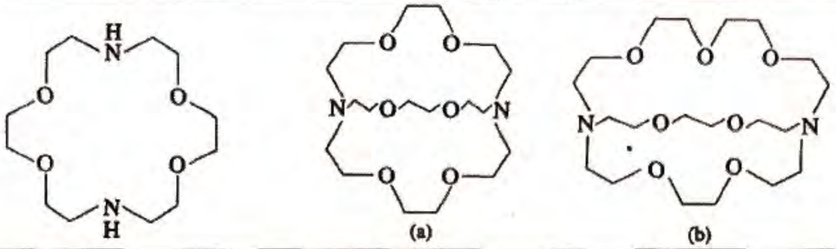
(a) (b)

Figure - 6

Amongst cryptands the most fascinating are the spherands with unique molecular architecture containing a spherical array of binding sites of nitrogen and oxygen atoms. The spherand (Figure-7) is one such species which is a 'Ubermensch' in its potentiality to encapsulate almost all the metal ions of the periodic table.

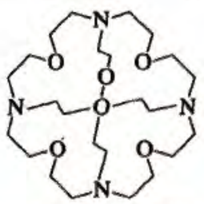

Figure - 7

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Aza – and Related Macrocycles:

This group of macrocycles contain nitrogen donor atoms or nitrogen in combination with oxygen, sulphur or phosphorus as donor atoms. They generally possess a strong affinity to form coordinate bonds with first row transition metal ions forming a unique family of complexes. Typical examples are shown in Figure-8 to 11. The most popular macrocycle (Figure-8) and the macrocycle with N_2S_2 donor atoms (Figure-9) are bonded to metal ions in a planar array (Figure-10) is a bicyclomacrocyclic complex where the ligand cage encapsulates the metal ion coordinating through six nitrogen atoms and (Figure-11) is a supermacrcycle in which five nitrogen atoms coordinate about the uranyl ion in a plane orthogonal to the O-U-O axis.

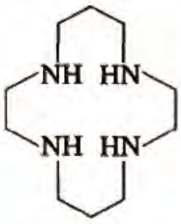

Figure-8

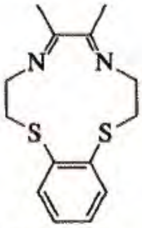

Figure-9

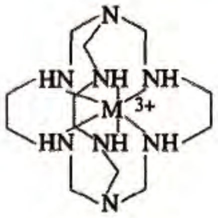

Figure-10

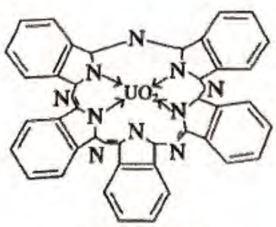

Figure -11

In the first category the metal ions are embedded within a large macrocyclic ring, whereas in the other type two mononuclear macrocyclic units are joined by common groups or bonds. Complexes shown in Figure-12 to 14 represent examples of some of these binuclear macrocyclic complexes.

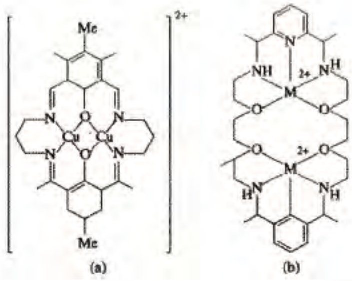

Figure-12

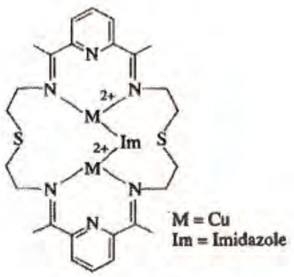

Figure -13

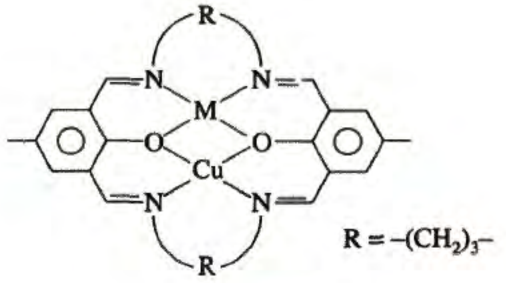

Figure -14

Alkoxy–Boron Bridged Encapsulation Compounds of Fe(II)

In the year 1973, a few clarthrochelates of Fe(II) with dimethylgloxime and boron compounds were reported by Rose and co-workers[1,2]. A series of alkoxy-boron bridged encapsulation compounds of Fe(II) of the type FeL3(BX)2 (L=2,4-pentanedione dioxymate ion or 1,2-diphenyl ethane-1,2-dione dioxymate ion and X=OH, OCH3 OC2H5, o-i-C3H7 or O-n-C4H9 were synthesized by our school adopting an in situ procedure using Fe(II) chloride, pentane, 2,4-dione dioxime or 1,2-diphenyl ethane-1,2 dione dioxime and boric acid[3]. The hydroxyl or alkoxy groups have been derived from the solvent molecules. The compounds are all diamagnetic well crystalline intensely coloured usually red or orange and are obtained in satisfactory yields. The preparations have also been achieved in some cases by alcohol exchange trans-esterification reactions. Infrared and electronic spectra show that they are isostructural and possess trigonal prismatic structures (Figure-15).

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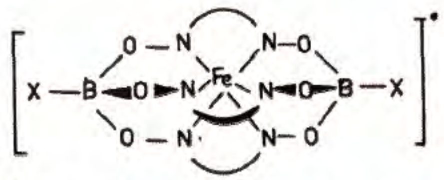


X= -OH, -OCH$_3$, -OC$_2$H$_5$, - O-i - C$_3$H$_7$, -O-n-C$_4$H$_9$

Figure - 15

The electronic spectra of the encapsulation compounds have been measured in acetonitrile in the region 10,000 to 30,000 cm-1. It is significant to note that no bands attributable to d-d transitions have been observed for any of the encapsulation compounds. However, all the complexes show an extremely intense band (ε=15,000) in the region 21,000 to 22,000 cm-1 having a half width of 3,500 cm-1 followed by a weak satellite band in the vicinity of 26,000 cm-1. Both of these bands are presumed to be charge transfer bands arising from M-π* transition.

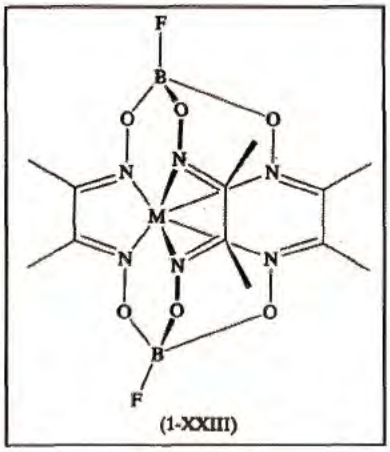


Figure - 16

Following this work, Russian workers[4] obtained the corresponding 1,2-cyclohexanedione dioxime complexes capped with BF by using BF3 (Figure-16) in acetonitrile in place of boric acid and alcohol. Alcoholysis complex affords the BOR derivatives. Experimental methods for the substitution of a wide variety of groups have subsequently been developed[5,6].

Fluoro-Boro Bridged Macrocyclic Metal Complexes

A number of 14- and 16-membered macrocyclic complexes of Nickel(II) and Cobalt(II) of the type, NiL2(BF2)2 and CoL2(BF2)2,2H2O (LH2=pentane-2,4-dione dioxime, 1,2-diphenylethane-1,2-dione dioxime or 1,2-difurylethane-1,2-dione dioxime have been synthesized along with copper(II) macrocyclic complex CuL2(BF2)2 where L represents the dianion of 1,2-diphenylethane 1,2-dione dioxime7. The preparative procedure involves a non-template cyclization of the neutral complexes of cobalt(II), nickel(II) and copper(II) of the corresponding oximes (LH2) by recation with boron trifluoride. The nickel(II) and cobalt(II) compounds are respectively diamagnetic and of low spin type having one unpaired electron with a nominal d7-configuration, while the copper(II) complex is a square planar. Spectral data support a square planar environment about the metal ion, coordination occurring through the nitrogen atoms of the ligands (Figure-17 to 20). The complexes are resistant to moderately concentrated acids dilute alkalies and a variety of organic liquids at ambient temperatures. They exhibit thermal stabilities to varying degrees.

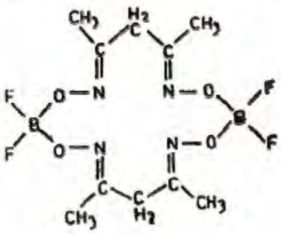
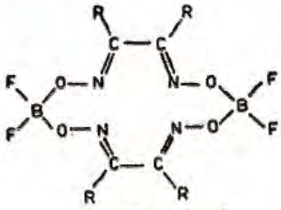
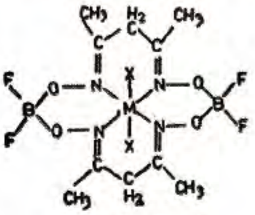


Figure - 17



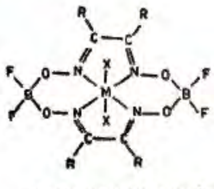
R = C$_6$H$_5$ or C$_4$H$_3$O

Figure - 18



M = Ni(II), X = nil
M = Co(II), X = H$_2$O

Figure - 19



R = C$_6$H$_5$, M = Cu(II), Ni(II) and X = nil
M = Co(II), X = H$_2$O.
R = C$_4$H$_3$O, M = Ni(II) and X = nil.
M = Co(II), X = H$_2$O

Figure - 20

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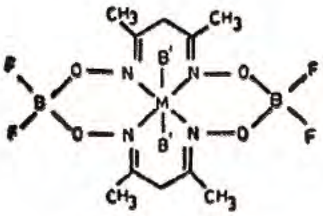
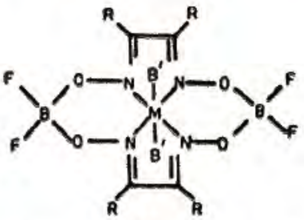
Orange-yellow fluro-boro bridged nickel(II) macrocycles (NiL) react with pyridine, β-picoline and γ-picoline and methyl amine to get bis-adducts of the type NiLB2' (L = 1,8-diboro-1,1,8,8-tetrafluoro-2,7,9,14-tetraoxa-3,6,10,13-tetraaza-4,5,11,12-tetramethylcyclotetradeca-3,5,10,12-tetraene [bofamcyclaene (14)]; 1,8-diboro-1,1,8,8-tetrafluoroboro and 1,8-diboro-1,1,9,9-tetrafluoro-2,8,10,16-tetraoxa-3,7,11,15-tetraaza-1,6,12,14-tetramethylcyclohexanedeca-3,6,11,14- tetraene [bofamcyclaene(16)] and B' = base)8. The bis-adducts are deep red or rosy red in colour. Significant differences are observed in magnetic and spectral behaviour of the bis-adducts of nickel(II) macrocycles for the three series of complexes (Figure-21,22). The bis-adducts of nickel bofamcyclaene 16 are paramagnetic with moments of 3.06 to 3.20 BM per gram of nickel(II). On the other hand, bis-adducts of nickel bofamcyclaene (14)] show magnetic behaviour and belong to the scarce hexacoordinated diamagnetic nickel(II) species. The bis-adducts of Ni bofaphcyclaene14 show intermediate magnetic moments. Values being 0.94 1.20 and 1.82 BM for py, βpic, and γpic, adducts respectively. The electronics spectra of the bofamcyclaene 16 adducts exhibit bands at 10,000 17,000 and 25,000 cm-1. The middle band splits into two components at 15,000 and 21,000 cm-1 due to lowering of symmetry to B4H Ni[bofamcyclaene (14)] adducts exhibit a broad band around 22,000 cm-1 which exhibit bathochromic shift with increasing strength of ligand in the axial positions nickel [bofaphcyclaene(14)] adducts exhibit spectral behaviour which is a combination of the spectral behaviours of the diamagnetic and fully paramagnetic Nickel(II) ions.



Ia

Ni [bofamcyclaene (16)]

Figure - 21



Ib

R= C_6H_5 Ni [bofaphcyclaene(14)]

R= CH_3 Ni [bofamcyclaene (14)]

Figure - 22

A series of fluoro-boro bridge Co(III) macrocyclic complexes of the type CoCyB'X where Cy represents the macrocyclic ligands [bofamcyclaene(14)] or [bofaphcyclaene(14)], X represents halide ions and B' represents a nitrogen donor based such as pyridine, β-picoline or γ-picoline have been prepared by the reaction of boron trifluoride on oxime complexes of the type Co(OximeH)2B'X[9,10]. Structurally important IR bands such as C—N, N—O, B — O B — F stretching vibrations have been identified some of the macrocyclic complexes show the general features of the spectra of octahedral cobalt(III) complexes while the spectra of the others can be interprented assuming a C4v or D4h symmetry (Figure-23). Ligand field splitting parameter 10Dq and interelectronic repulsion parameter be have been calculated for the octahedral complexes. The tetragonal parameter (Dt) values for low symmetry complexes are all positive and are of the order of 600 cm-1 thermal studies manifest greater thermal stability for [Co(bofamcyclaene(14)B'X] compared to bofaphcyclaene(14) B'X . within a particular series containing the same axial halogen atom, the stabilities found in order [Co(bofamcyclaene(14)PyX]< [Co(bofamcyclaene(14)β-picX < < [Co(bofamcyclaene(14)γ-picX.

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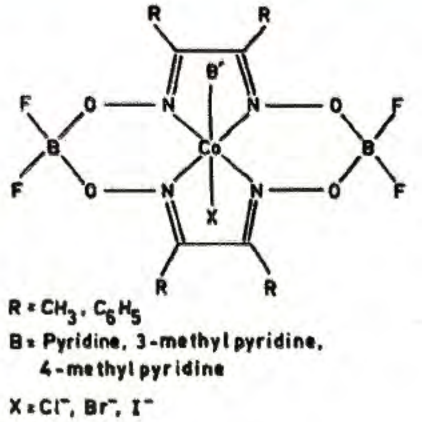

Figure - 23

Macrocyclic complexes of nickel(II) with fluorboro ligands of the type (Fig-24) have been prepared by template condensation of the parent dioxime ligand complexes [NiLH2]Cl2 with borontrifluoride. The tetra-aza-coordinated complexes are diamagnetic. The penta and hexa-aza-coordinated complexes have subnormal magnetic moments and their electron spectra indicate that pin singlet and spin triplet energy levels lie in the spin cross over region. Polarographic studies show that the complexes undergo irreversible or quasireversible one electron redoxy reactions. For the macrocyclic diamgnetxic planar complexes the redox process is more anodic than that for the paramagnetic square pyramidal or octrahedral complexes. It indicates that for the latter complexes the donor properties of the nuceophilic secondary amines are more predominant over the reverse dative π-bonding mechanism which is of greater importance for the planar complexes[11,12].

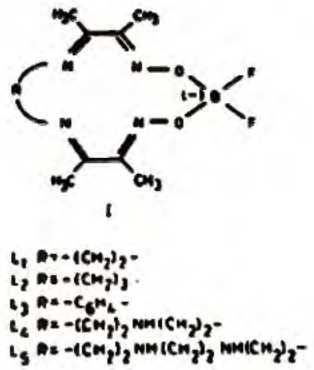

Figure 24

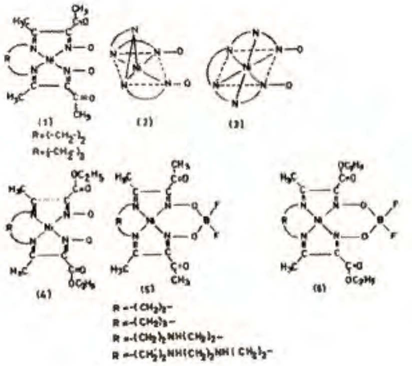

Figure 25

A series of tetraaza, pentaaza and hexaaza fluoroboro bridge macrocyclic nickel(II) and cobalt(III) complexes containing methyl and-CH3CO or –COOC2H2 as pendants on the macro ring have been synthesized[13]. The precursor nickel(II) nitroso complexes are remarkably different in spectral magnetic and electro chemical behaviour from the respective macrocyclic complexes (Fig-25). The macrocyclic ligands provide facile electron delocalization resulting in a weaker ligand field corresponding to the spin cross over ligand. The precursors and macrocycles undergo two step one electron reduction and the redox behaviour depends on the macrocyclidc effects, ring size and substituents on the macro ring apart from the electro static interactionof the donor nitrogen atoms[14].

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Dinuclear Macrocyclic Fluoroboro Bridge Complexes of Cobalt(ii) and Nickel(ii)

Dinuclear fluorboro bridge macrocyclic complexes have been synthesized by treating boron trifluoride on bis=(diacetylazinedihydrazone)dinickel(II)-dicobalt(II) complexes[16]. The complexes ,possess the stoichiometry [M2(DAADHBF202X4](BF4)2, [M-Co(II) X=Cl⁻, Br⁻, I⁻, SCN⁻; Ni(II) , X=SCN⁻). They are ionic in nature and the IR spectral data show the existence of fluoroboro groups as BF2+ and BF4- species pairs of former group occur as bridge heads each encompassing two adjacent NH2 groups in the inner sphere of the macrocyclic ligand frame and the latter occupies the outer coordination sphere of the complexes (Fig-26). Polar graphic redox studies show three single electron reduct steps and the thermodynamic parameters viz E1/2 values point to the macrocyclic structure of the complexes[15].

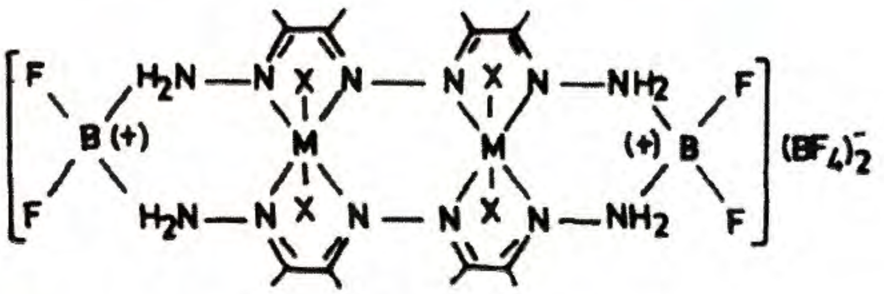

Figure 26

Fluoroboro Bridged Dinuclear Encapsulation Compound of Fe(ii)

A new dinuclear Fe(II) encapsulated complex (Fig-27) has been isolated by an insitu reaction of Fe(II) , 2-3 butanedioneazinedioxime and borontrifluoride in butanol medium. It has been characterized by spectral studies[16].

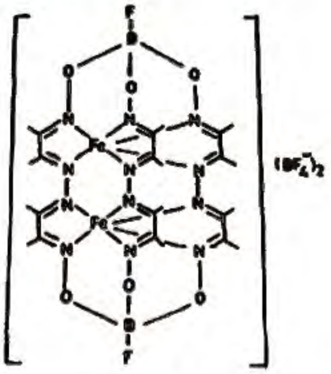

Figure 27

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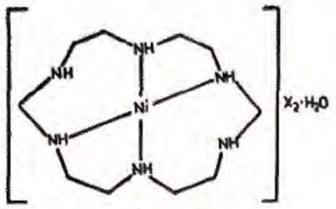
Section – C: Macrocyclic Complexes:

A novel series of Nickel(II) macrocyclic complexes of the type (Figure-1) NiLX2 (where X=Cl-, Br-, I-, NO3- and ClO4-) with the cyclic ligand L=1,3,6,9,11,14-hexaazacyclohexadecaane,[16] ane-N6 has been synthesized by the action of formaldehyde on bis-(diethylenetriamine) Nickel(II) salts. They are obtained as shining yellow diamagnetic crystals and have been characterized by IR, PMR and electronic spectral studies[1].



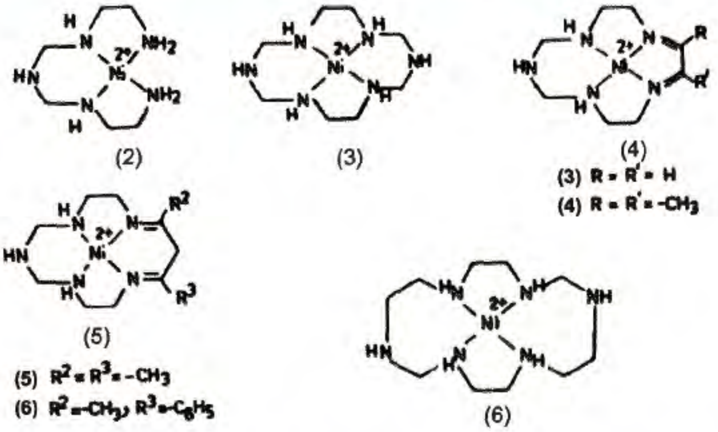
I

(X=Cl^-, Br^-, I^-, NO_3^-, ClO_4^-)

Ni ([16] ane N_6) $X_2 \cdot H_2O$

Figure - 1

A saturated unsubstituted hexaaza 14 membered macrocyclic complex of Nickel(II) was prepared by a successive and stepwise metal ion assisted template condensation (Figure-2,3). The quadratic bonding of the macrocyclix and its precursor to the metal ion was established from magnetic IR, EPR and electronic spectral data. Subsequently a new series of macrocyclic complexes of Nickel(II) was isolated through the reaction of α and β diketones. With the complex of Nickel(II) with 1,4,6,8,11 pentaazaonedecane. The macrocycles have been found to possess square planar coordination around the metal ion (Figure-4,5,6). The complexes undergo one electron reversible reduction in the ehalf range – 1.05V to 1.36V and their redox potentials correlate with ligand field strength Dq^{xy} of the macrocycles[2,3].



A series of macrocyclic complexes of nickel(II) has been synthesized by the action of formaldehyde on [bis(benzilmonohydrazone)diimine] nickel(II) complexes (Fig-7)[4]. The macrocyclic complexes and the precursoers have the spin-singlet ground state, are square planar in structure and show one ligand field band near 19,000 cm-1. The complexes show one electron reduction in two discrete steps with E1/2 values in the ranges -0.33 to -0.55 V and -1.53 v to -1.63 V respectively. The E1/2 values have been examined thermodynamically for each macrocycle and the precursor and ei have values macrocycle Cy and its corresponding precursor. The analysis suggest formation of ligand anion radical in the first step and reduced metal ligand anion radicalcomplex in the second step.

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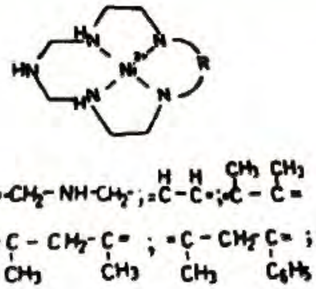
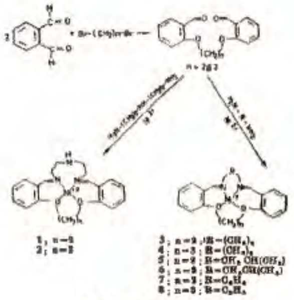


Figure 7

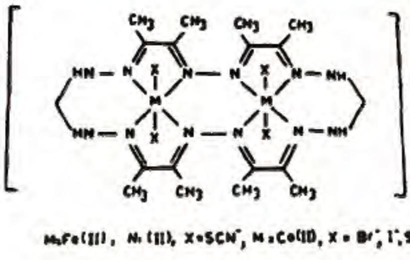
A series of nitrogen-oxygen donor macrocyclic complexes of nickel(II) of the type N3O2 and N2O3 has been investigated (scheme-1). The ligands and metal complexes have been characterised by IR, NMR and EV vis spectrometry. The macrcycles undergo two steps reduction E1/2values ranging from -1.0 to -1.2 V and from -1.4 to -1.7 V.the first step of reduction has been attributed to the formation of a metal stabilized ligand anion radical. Tha magnitude of E1/2 depends on ligand structure.



Scheme - 1

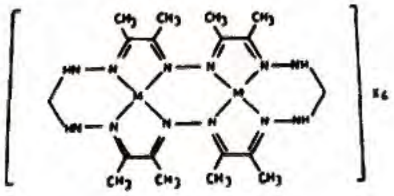
Binuclear Macrocycles

A series of binuclear macrocyclic complexes have been prepared by the action of formaldehyde on (i) tetrathiocynato bis (3,6-dimethyl-2,7-dioxo-4,5-diazaocta-3,5-diene-2,7-dihydrazone) dinickel(II) dicobalt(II) and diiron(II), (ii) perchlorate complex of copper(II) and (iii) corresponding tetrabromo and tetraiodo complexes of Co(II). Structures of these complexes have been elucidated on the basis of IR and electronic spectra (Fig-8,9). These complexes exhibit two well defined diffusion controlled reversible or quasi reversible polargraphic reduction waves involving transfer of one electron at each step. the intermediate complexes contain the pair of metal ions in mixed oxidation states (M+1, M+2) and in the second step both the metal ions are reduced to +1 oxidation state. In the case of iron(II) and copper(II) complexes a third wave is observed where one of the metal ions is stabilized in zero valant stage indicating the macrocycle to be a strong π-acceptor legand.



M=Fe(II), Ni(II), X=SCN⁻, M=Co(II), X=Br⁻, I⁻, SCN⁻.

Figure - 8



M=Cu(II), X=ClO₄⁻

Figure - 9

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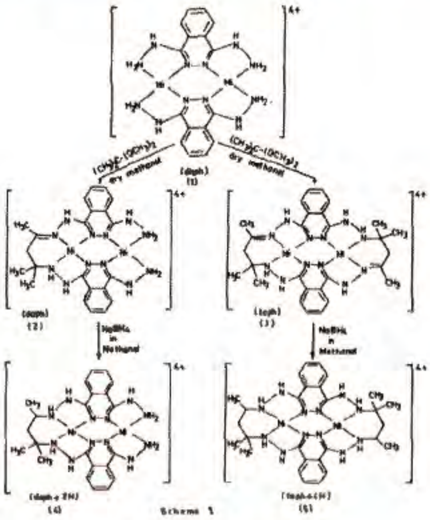
Dimeric bis-(dihydrazinophthalazine) nickel(II) ion undergoes Curtis typereecation with 2,2-dimethoxypropane in the mole ration 1:1 and 1:2 yielding binuclear complexes of the type Ni2 (daph)X4,nH2O and macrocycles of the type Ni2(taph), X4.nH2O(X=Cl-, ClO4-, n=4. These complexes react with sodium borohydride in methanol medium when the imine groups are selectively reduced with offtake of 2 and 4 hydrogen atoms respectively [(daph=2H) and (taph+4H)] (Scheme-2). The reduced ligands are observed to be stronger donors The complexes of dhph and daph and macrocycles of taph are electro chemically reduced in two successive states. On the other hand the daph +2H and taph+4H complexes undergo 2 electron one step reduction.the converegence of successive reduction processes arises from a lower degree of unsaturation in the ligand structure of the second type of complexes that diminishes the tendency for the generation of ligand anion radical7.



Scheme - 2

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Section – D :Photochemistry of Macrocyclic Complexes

Supramolecular photochemistry [1-3] has become an expanding branch of supramolecular chemistry that covers various aspects such as light induced ionophore selectivity, charge separation, photoinduced energy migration, selective photochemical reactions, light conversion based on absorption-energy transfer-emission process etc. Marek Pietraszkiewicz, A.K.Rout and their co-workers have made significant contributions on light converting supramolecular devices. Several ligands of various topology : macromonocyclic, macrobicyclic, cylindrical, acyclic and pendant type bearing photoactive units: 3, 3'- bi-isoquinoline -2,2'-dioxide, methyl-2- pyridine and dibenzoilmethane display an efficient energy transfer from the excited triplet state of the ligand to the resonance level of the lanthanide cation. The lanthanide complexes are thus highly luminescent. The Eu(III) cryptate of 3 exhibits highest quantum yield for the Eu(III) emission (0.17)[4].

Macrocyclic and macropolycyclic ligands incorporating heteroatomic N-oxides (3,3'-biisoquinoline-2,2'-dioxide unit (Fig: 1-6) form strongly luminescent complexes with lanthanide ions: Eu(III) and Tb(III). Most of these complexes gave stable water solutions with excellent luminescent properties with luminisence life times in the range of 0.2 to 0.7 ms and the quantum yields for emission upto 0.25. Several complexes are stable also in the presence of affecting ions, such as Ca(II) or phosphates. These features make them attractive as potential fluorescent levels for time resolved fluoroimmunoassays[5].

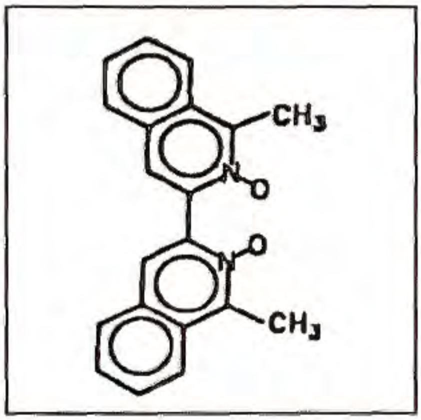

Fig - 1

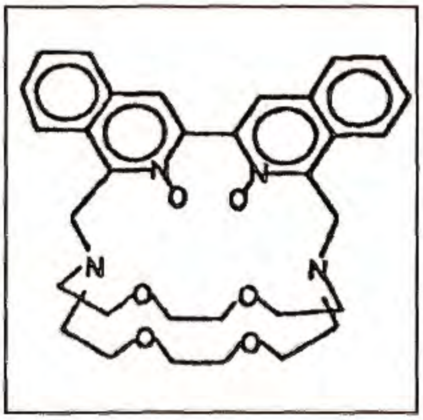

Fig - 2

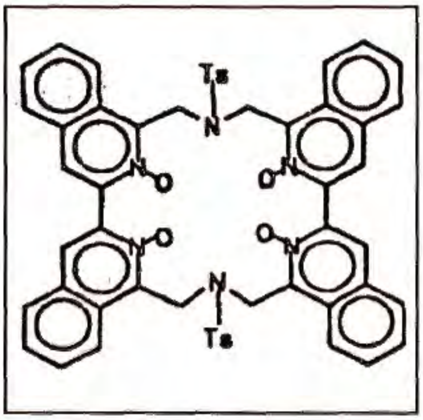

Fig - 3

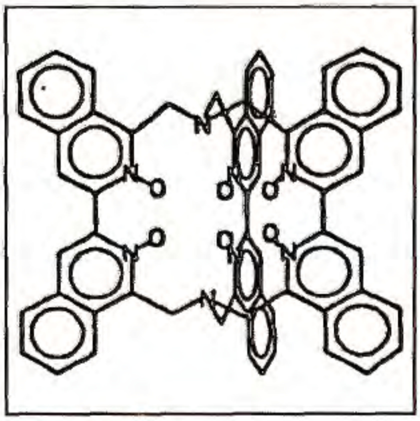

Fig - 4

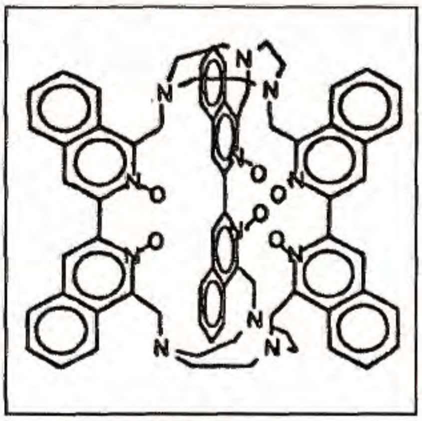

Fig - 5

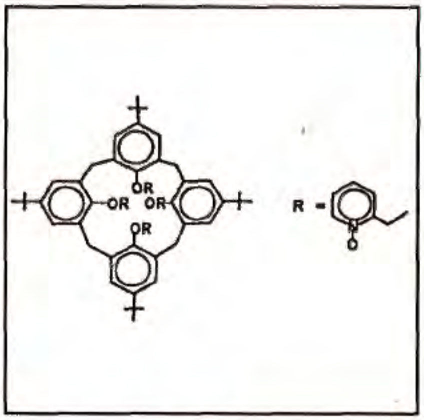

Fig - 6

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Three novel ligands incorporating two or three 3,3'-biisoquinoline-2,2'-dioxide units have been synthesized using modified standard methods of cyclization (Fig: 7-9). These ligands formed photoactive mononuclear complexes with a Eu(III) cation. The ligand with two photoactive units displayed a better quantum yield for the Eu(III) emission 0.064 on UV excitation than the other two complexes incorporating three units, whose luminescence quantum yields have been estimated to be below 0.01. The luminescence of the Eu(III) complex with two sensitizing units was not stable in aqueous solution, whereas with the two other complexes, the luminescence in solution remained for about a couple of days[6].

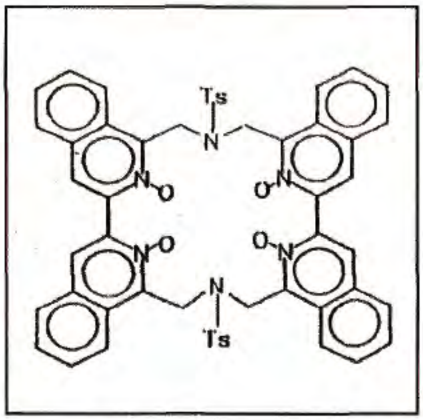

Fig - 7

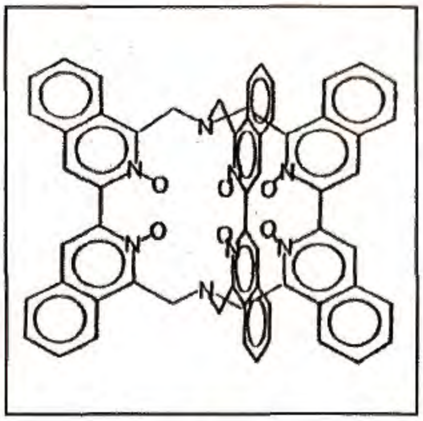

Fig - 8

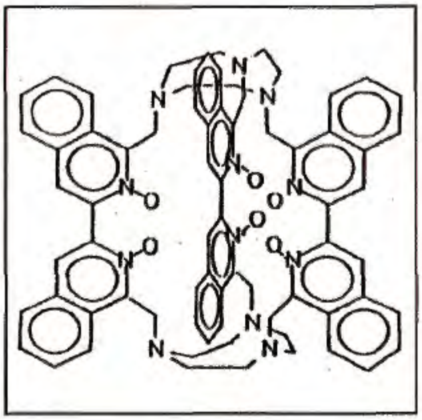

Fig - 9

C-alkylation of dibenzoilmethane by 1,1' bis(bromomethyl)-3,3'-bisquinoline-2,2'-dioxide leads to an acyclic ligand capable of forminh Eu(III) complexes in its neutral and ionized forms (Fig-10).

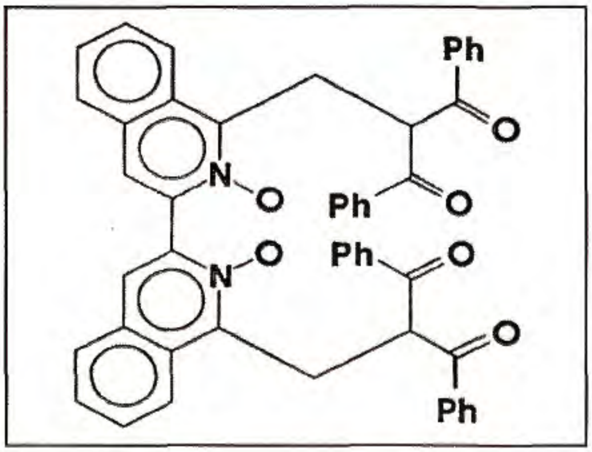

Figure - 10

The neutral 1:1 complex with $EuCl_3$ showed a red fluorescence when irradiated at 330 nm, with the strongest emission line at 614 nm; the quantum yield was 0.05. The ionized lgand forms complexes with EuCl(II) and $CF_3SO_3Eu(II)$ with very similar fluorescent spectra except for unexpectedly low quantum yields[7].

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Nanocoating of Silicon Oxynitride on Titanium Dioxide Nanotubes by Microwave PECVD and its use in Sensors at Ambient Temperature

Dr. Indu Bhusan Mishra

Dubnikova et al.[1] in 2002 by quantum mechanical calculations showed that ions like Li^+, Cu^+, Zn^{2+} and In3+ are of proper size to fit in the cavity of cyclic organic peroxides such as TATP or HMTD as shown below:

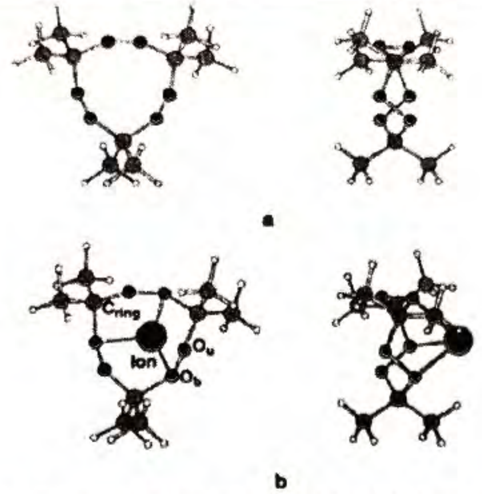

Figure 1. Top view (left) and side view (right) of the lowest-energy geometry for (a) the TATP molecule and (b) the ion–TATP complex (ion = Li^+, Cu^+, Zn^{2+}, Cd^{2+}, In^{3+}).

Figure - 1

Novel Detection of Triacetone Triperoxide

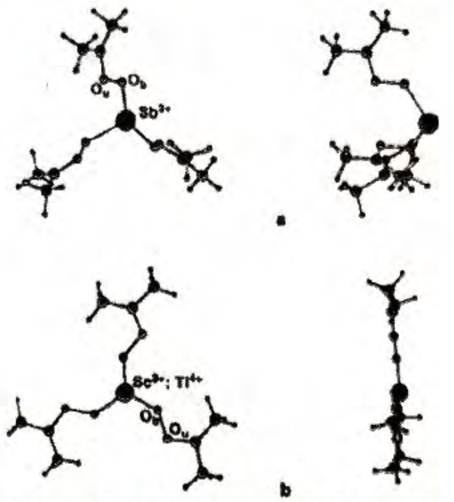

Figure 2. Top view (left) and side view (right) of the lowest-energy geometry for (a) the Sb^{3+}–TATP complex (upper panel) and (b) the Ti^{4+}–TATP complex (lower panel).

Figure - 2

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We contemplated to create a test platform to see if the complex formed in at least some ions. At the time we were in our early stage of work with Titanium dioxide nanotubes (TiNT) and our laboratory was involved in solar energy harvesting and sensor work and we were endowed with two bright postdoctoral fellows from IIT Mumbai, Drs. Subarna Banerjee and Sushant Mohapatra. We substituted Zn^{++}as ZnO onto freshly prepared TiNT where we have abundant TiOHsites by ion exchange with $Zn(CH_3COO)_2$:

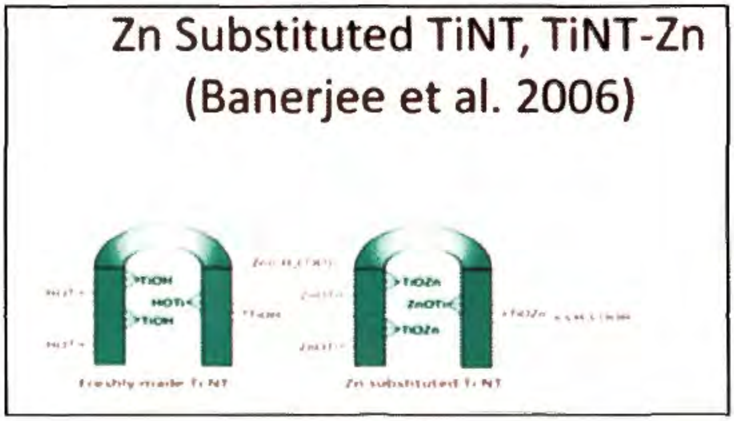

Figure - 3

This is annealed at ~ 500°C tohave ZnO in a Titania Anatase framework. Furthermore, we found that when this framework was exposed to TATP, it formed a complex resulting in an increase in electrical conductivity of three orders of magnitude! Rest was designing a sensor:

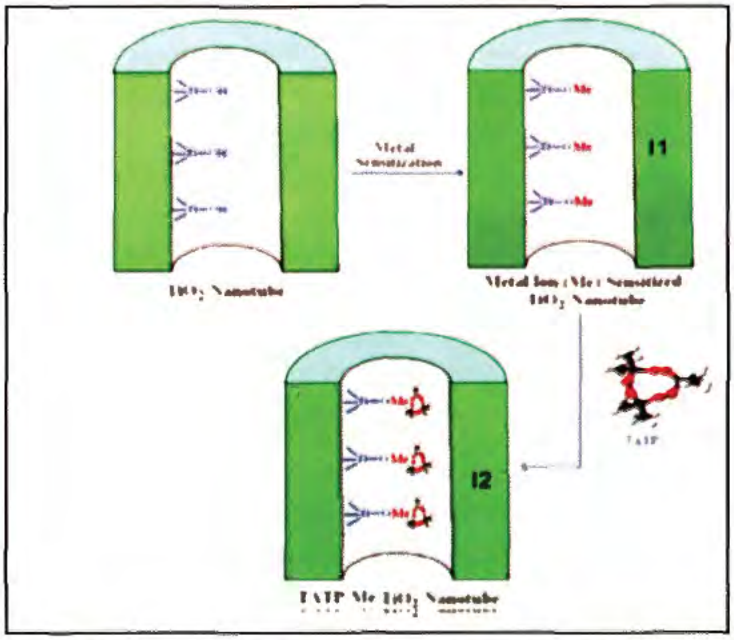

Figure - 4 TiNT showing complexation with TaTP-OZn

I am showing you the design of the sensor and the result will be shown in the subsequent diagram – vertically grown TiNT-OZn is connected on both sides by Ag-epoxy to a Potentiostat and then to a computer.

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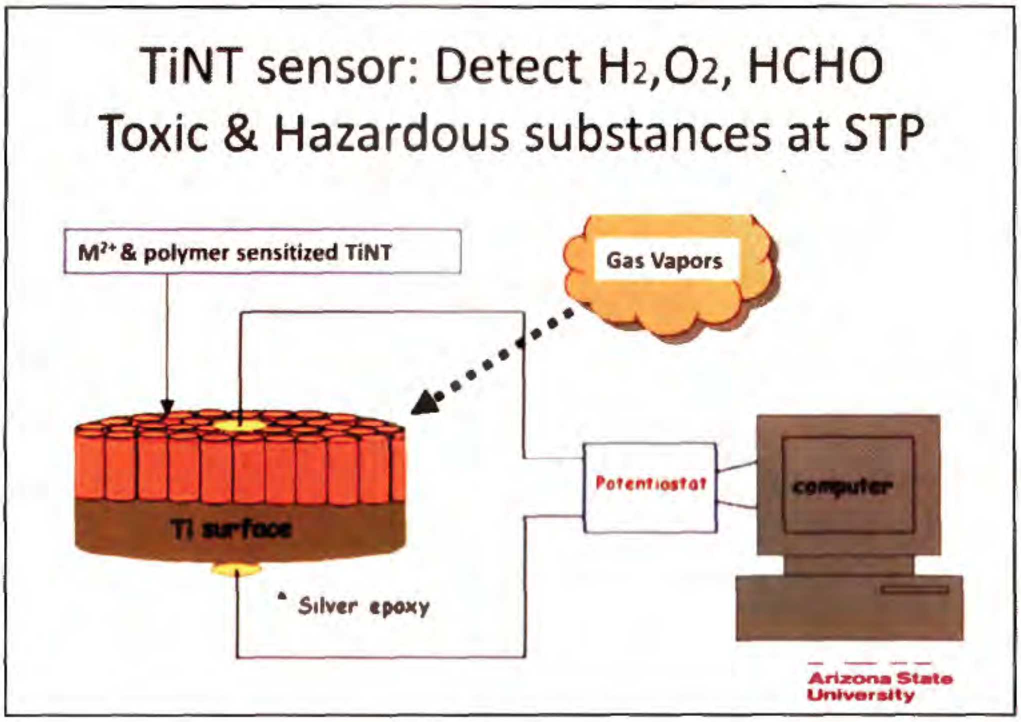

Figure - 5 Testing set up

After some testing under various weather conditions, we found that the conductance readings were affected by humidity in the air and sodium chloride aerosol. We felt the need of developing a protective coating for the nanotube arrays. By this time, I had moved out of Maryland and returned to Scottsdale Arizona where I lived during 1977-81 when I was a member of the Airbag discovery and testing team with Talley Industries of Arizona. I am fortunate to say the technology we developed there came into use in first generation airbags and the second and third generation bags also had some of our work initiated at Talley. Air bag now has grown to be manufactured in over 50 million units per year for use in vehicles. Airbag technology has been used in dropping payloads to Mars and finds its use in dropping manned capsules from spaceships in case of emergency. As an Adjunct professor at Arizona State University, we studied a method of coating and developed the Microwave plasma enhanced Chemical vapor deposition technology (PECVD"which provides a barrier for both moisture and sodium chloride aerosols. The technology is described in a recently allowed US Patent # 9,535,046 dated January 3, 2017.

Typical coationg condition was 2.3 GHz microwave PECVD with PlasmaQuest instrument. The substrate was at 200°C in a chamber at 550 mTorr. Gas flow rates were, 70 sccm ammonia, 15 sccm each of silane and nitrous oxide with 1000 sccm of He as the carrier gas. With a deposition time of 85 s, a coating thickness of ~11 nm of SiOxNy was obtained.

Please note that by anodic oxidation of Ti foil, we get vertically oriented titanium dioxide nanotubes (TiNT) that grow like a forest. When plasma deposition of SiOxNy occurs on the vertically oriented nanotubes, they collect on the top rims and the sides and the inside of the tubes are spared leaving room for sensing of TATP.

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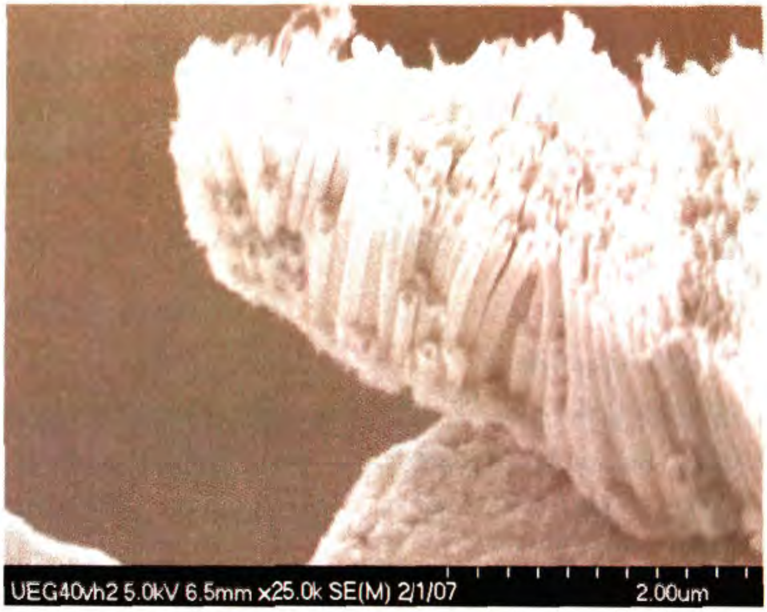

Figure 6. TiNT grows as "forest"

We measured the sample composition after the silicon oxynitride deposition by Rutherford scattering:

Sample 1 Si 0.12, O 0.50, N0.07, H 0.13 Ti 0.17

Please note that all H from the sample do not get removed as H_2O. Instead they adhere as ~12% H.In the plasma several ions, atoms, free radicals, and electrons (SiH_2, SiH, Si, H_2, H, e^-, NH, N , N_2, O in nonstoichiometric ratios) are formed. They assemble on nanotube rims forming SiOxNy.H.

Test results from TATP exposure is shown in the following diagram:

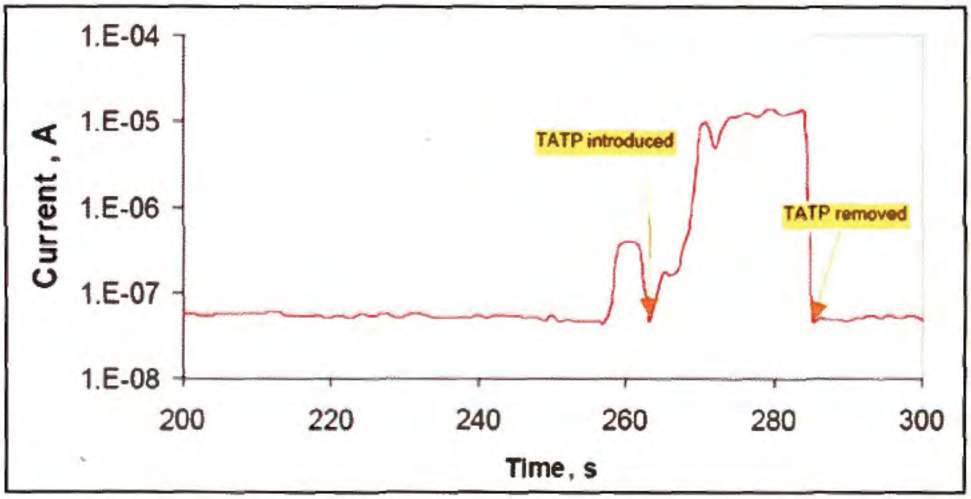

Figure - 7. Typical result when test is done in a dry box

Notice that the complex is a very labile one. To make the sensor reusable immediately, it may be subjected to a UV pulse. We are making efforts to miniaturize this sensor.

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Research Publications of Professor (Dr.) Dayanidhi Patnaik

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Dr. Chitta Ranjan Mishra

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No. 4153 June 4, 1949 NATURE 883

EFFECT OF LIGHT ON COMBUSTION OF HYDROCARBONS

(Nature, Vol. 163, No. 4153, pp 883-885, June 4, 1949)

By PROF. R. G. W. NORRISH, FRS and D. PATNAIK
Department of Physical Chemistry, University of Cambridge

The slow combustion of hydrocarbons in general takes place by a kinetic process which Semenov[1] described as chain reaction showing 'degenerate branching'. According to this conception, the hydrocarbon is first oxidized to a moderately stable intermediate, which is itself oxidized to the final products, namely, carbon monoxide, water, etc. Thus a stationary concentration of the intermediate is built up during the reaction, which reaches a maximum at the time of maximum velocity. According to Semenov's conception, the intermediate is responsible for the starting of new chains by an alternative reaction with oxygen, and a delayed or degenerate branching results.

In the case of methane[4] and ethylene, the intermediate may be identified with formaldehyde, which, as shown by Bone, Haffner and Rance[2] and by Harding and Norrish[2], reaches a maximum concentration at the point of maximum velocity, and which when added to the reactants in the right amount (c. 1.0 per cent) compleely removes the induction period[4].

The complete scheme derived for the oxidation of methane[6], based on the work of Norrish and Foord on methane[4] and Axford and Norrish[5] on the oxidation of formaldehyde, is as follows:

$k_1\ CH_4 + O_2$	$= CH_2O + H_2O$	Initiation and degenerate branching
$k_2\ H_2CO + O_2$	$= H_2CO_2 + O$	
$k_3\ O + CH_4$	$= CH_3 + OH$	
$k_4\ OH + CH_4$	$= CH_3 + H_2O$	Propagation
$k_5\ CH_3 + O_2$	$= H_2CO + OH$	
$k_6\ CH_2O + OH$	$= CO + H_2O + H$	Coupled formaldehyde chain*
$k_7\ H + O_2 + H_2CO$	$= CO + H_2O + OH$	
$k_8\ H + O_2 + X$	$= HO_2 + X'$	Termination*
$k_9\ OH + \text{surface} \rightarrow$	termination	

*Reactions (7) and (8) are only formally to be regarded as ternary reactions. The transition complex HO_2 formed with c. 50 k.cal. is unstable unless deactivated (reaction (*)), and reactive only if it encounters a formaldehyde molecule (reaction (7)) before it decomposes, or is deactivated.

In this mechanism, the concentration of formaldehyde, initially zero, grows very slowly at first, during the induction period; and laer, as the delayed branching by reaction (2) akes effect, at an ever increasing rae. But the rate of the oxidation of formaldehyde by reactions (6) and (7), which as is generally agreed depends approximately on the square of its concentration, grows still faster, so that eventually a stationary concentration is reached when its rate of destruction is equal to its rate of production. At this point the velocity of reaction must cease to increase; it settles down to a steady value which finally falls off as he reactants are consumed. Thus we get the familiar S-shaped pressure – time curves. A similar scheme has been derived for the oxidation of ethylene[6].

The steady rate is readily shown to be given by the kinetic equation[6]

$$\frac{-d(\mathrm{Hy})}{dt} = \frac{k_4}{k_6}\left(k_1(\mathrm{Hy})(\mathrm{O_2}) + \frac{k_2k_4k_7(\mathrm{Hy})^2(\mathrm{O_2})Pd}{2k_7k_8\sigma + 2k_6k_9P^2d}\right), \quad (1)$$

where (Hy) stands for methane or ethylene, σ the specific surface activity per square cm. for termination by reaction (9), P the total pressure in the system and d the diameter of the reaction vessel. The first term on the right-hand side represents the initiation process, the second the propagation; and the former is generally negligible in comparison with the latter. With methane, the first term in the denominator is large compared with the second, which can be neglected; with ethylene, which oxidizes at a lower temperature, the two terms are of comparable magnitude. This circumstance is responsible for minor differences in their oxidation kinetics.

This general view of the oxidation of methane and ethylene led us to the conclusion that the combustion reaction should be accelerated by light, which is known to dissociate formaldehyde into free radicals, for the degenerate branching reaction (2) would now be augmented by the photochemical process as a chain starting mechanism.

$$H_2CO + h\nu = H + HCO$$

$$\searrow H + CO$$

If the rate of absorption of light by formaldehyde is viven by $K(H_2CO)I$, where I is the incident intensity,

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the rate equation now becomes modified to

$$\frac{-d\mathrm{Hy}}{dt} = \frac{k_4}{k_6}\left(k_2(\mathrm{Hy})(\mathrm{O_2}) + k(\mathrm{Hy})I + \frac{k_2k_4k_7(\mathrm{Hy})^2(\mathrm{O_2})Pd + kk_4k_7(\mathrm{Hy})^2IPd}{2k_7k_9\sigma + 2k_6k_8P^2d}\right). \quad (2)$$

Subtracting the rate in the dark (R_D) from the rate in the light (R_L) we obtain:

$$R_L - R_D = \frac{k_4}{k_6}\left(k(\mathrm{Hy})I + \frac{kk_4k_7(\mathrm{Hy})^2IPd}{2k_7k_9\tau + 2k_6k_8P^2d}\right); \quad (3)$$

Or, keeping σ I and d constant:

$$R_L - R_D = (\mathrm{Hy}) + \frac{a(\mathrm{Hy})^2P}{b + cP^2}. \quad (4)$$

If, in addition, the total pressure P be kept constant by making up with nitrogen,

$$R_L - R_D = (\mathrm{Hy}) + K(\mathrm{Hy})^2 \quad (5)$$

These predictions have all been confirmed. We used a cylindrical quartz reaction vessel (diameter 3.4 cm., volume 175 c.c.) in a horizontal electric furnace lined with polished aluminium with a quartz window 7cm. in diameter at one end. A beam of light of high intensity obtained from a high-pressure point-source mercury arc, burning 1 KW., and 'cooled' by passing through 50cm. of water contained in a tank with parallel quartz sides, was focused into the furnace by means of a searchlight mirror of polished aluminium. The reaction was followed by pressure change, measured by a glass spoon gauge sensitive to a pressure of 0.05 mm. mercury. Fig.1 shows a typical result.

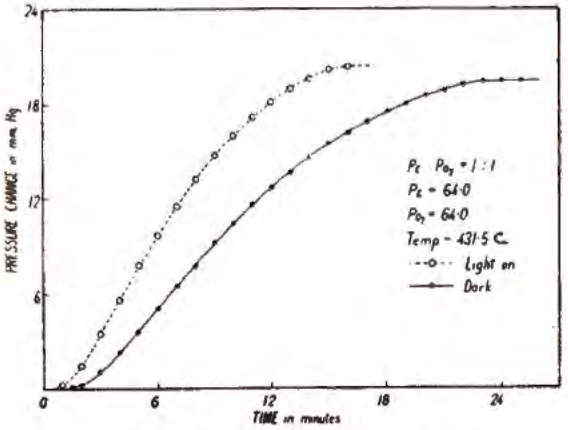

Fig. 1. Effect of light on the slow oxidation of ethylene

When the light beam was passed through a colour filter of 0.5 per cent solution of quinine hydrochloride 7cm. thick, which cuts out all light of wave-length shorter than 3600 A., he acceleration due to the light was very nearly (90 per cent) suppressed. The formaldehyde absorption spectrum extends from 3750 A. to beyond 2500 A., whereas the spectrum of the lamp extended to 2450 A.; thus the active light lies in the ultra-violet in the region covering the absorption band of formaldehyde. With a more concentrated solution of quinine hydrochloride (2.5 per cent) cutting out all light of less than 4000 A., the effect was completely suppressed.

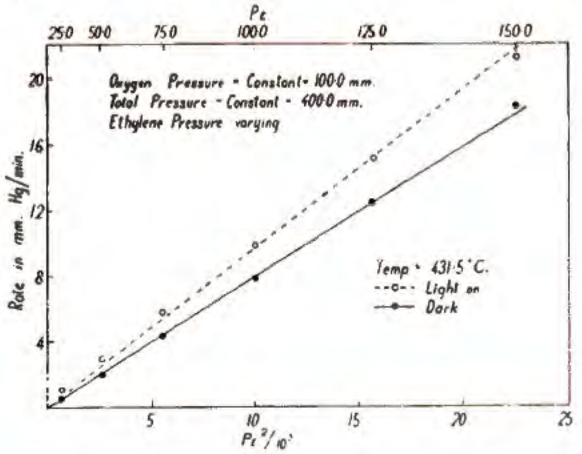

Fig.2. Effect of light on the slow oxidation of ethylene; ethylene varying, total pressure constant

Figs.2-5 show that R_L and R_D conform to equations (1) and (2), and that $R_L - R_D$ is independent of (O_2) and approximately proportional to $(\mathrm{Hy})^2$, as is required by equation (4) if the terms in Hy (initiation) are small compared with the terms in Hy (initiation) are small compared with the terms in Hy^2 (propagation), and if b is large compared to cP^2, as it is in the case of methane. With ethylene we kept the total pressure P constant by addition nitrogen, and therefore $R_L - R_D$ is given by equation (5). Under these conditions, when (Hy) is small the first term in equation (5) preponderates, and ($R_L - R_D$) is more nearly proportional to (Hy) than $(\mathrm{Hy})^2$. The fact that the experimental points for low (Hy) in Fig.2 lie above the line is in accord with this.

By working close to the ignition limit with ethylene (C_2H_4 = 225 mm., O_2 = 318, temp. 431° C.) we were

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readily able to convert a 'slow' dark reaction into an ignition by irradiation; but in this region eqation (1) is no longer obeyed owing to the large measure of self-heating as the ignition limit is approached.

These results accord well with the reaction scheme based on formaldehyde outlined above, and confirm the kinetic formula previously deduced. They show, in effect, that the degenerate branching process can be powerfully affected by light without altering the character of the reaction; and the effect is all the more striking when it is remembered that the initial reactants are completely transparent to the light used.

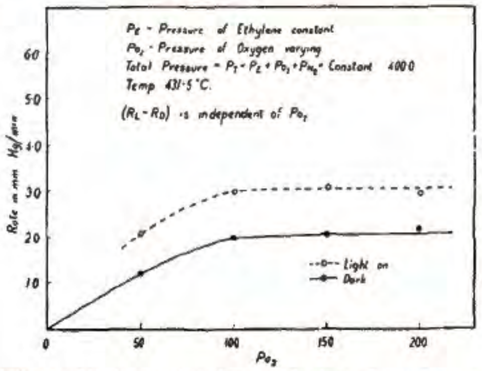

Fig. 3. Effect of light on the slow oxidation of ethylene; oxygen varying, total pressure constant

By using the weaker colour filter (0.5 per cent quinine hydrochloride) it was shown that the effect still persists feebly in light the spectrum of which lies between 3600 A. and 4000 A. Now the pre-dissociation limit of formaldehyde as shown by the threshold of fluorescence is at c. 3000A. [7], and it must therefore be concluded that some such reactions as

$$H_2CO - hv = H_2CO'$$

$$H_2CO' + O_2 = H_2CO_2 + O$$

take place in this region; that is, that reaction (2) is somewhat enhanced by light which excites, but does not split, the formaldehyde molecule.

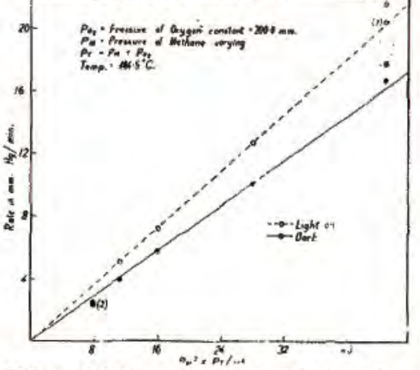

Fig. 4. Effect of light on the slow oxidation of methane: methane varying

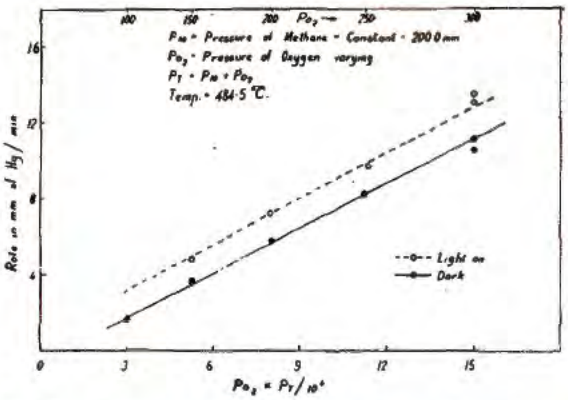

Fig. 5. Effect of ligh on the slow oxidation of methane; oxygen varying

With heavier hydrocarbons the characteristics of degenerate branching are similarly observed, and we believe that the heavier aldehydes which are first produced are similarly responsible for the delayed branching reaction. On this basis it is possible to build a self-consistent mechanism of a pattern resembling the simpler reactions treated here [6]. It is significant that light readily accelerates the oxidation of butane, and the shapes of the curves in the dark and in the light suggest different end points; it is probable that the phenomenon will be found to be general for hydrocarbons.

This photochemical effect provides a new experimental approach to the study of the reaction kinetics of combustion, and cannot fail to be revealing.

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CARBONATES OF URANIUM

By BALARMA SAHOO and Dr. D. PATNAIK

MILLER and co-workers[1] for the first time isolated uranyl carbonate, prepared by the action of carbon dioxide under pressure on uranium trioxide, ammonium and sodium uranates. A different process was followed by Chernyaev and co-workers[2], who prepared the compound by the treatment of aqueous and alcoholic solutions of uranyl nitrate with carbon dioxide under pressure or aqueous suspensions of uranium oxide, UO_3, under normal conditions. A simple and convenient method has been developed by us for the preparation of the compound. The hitherto unreported compound uranium (IV) oxyearbonate, the preparation of which is described below, on exposure to dry air undergoes simultaneous oxidation and dehydration, resulting in the formation of the compound UO_2CO_3, 2.5 H_2O, the progress of the oxdation being indicated by the gradual change of colour from dark green to bright yellow. This hydrated uranyl carbonate, when heated in vacuo at 160°, gives the anhydrous compound UO_2CO_3, which is stable up to 500°C.

Uranyl ion undergoes photo-reduction when exposed to sunlight in the presence of reducing agents such as alcohol or formic acid. When ammonium carbonate is added to a photochemically reduced solution of uranyl nitrate or formate, a green precipitate is obtained in a fine state, which on washing turns dark green. Analysis of the freshly prepared moist compound was carried out after ammonia had been tested for and found to be absent. The uranium to carbonate ratio was found to be 1 : 1 by semi-micro combustion method. The water content was found to vary from time to time due to the moist compound being used for analysis. The total uranium content was estimated as U_3O_8 and also by the Jones reductor method. That all the uranium exists as uranium (IV) was proved by directly titrating the solution of the compound in 2 N sulphuric acid against standard potassium permanganate. On account of the extreme proneness of the compound to oxidation and hydrolysis at hight temperature, and also our lack of equipment for isothermal dehydration at low temperature, it has not been possible to get the compound either in the anhydrous state or in a definite state of hydration.

The isolation of uranium (IV) oxycarbonate offers a new route for the syntheses of uranium (IV) compounds[3]. Investigations are proceeding with the view of preparing some new compounds of uranium as well as the dioxide[4].

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Sept. 29.

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Reprinted from "The Proceedings of the Indian Academy of Sciences",
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THE PHOTOLYTIC PREPARATION OF URANIUM TETRAFLUORIDE

BY D. PATNAIK AND BALARAM SAHOO
(Department of Chemistry, Ravenshaw College, Cuttack)

Received January 9, 1959
(Communicated by Prof. G. N. Ramachandran, F.A.Sc.)

INTODUCTION

The The Photolytic Preparation of Uranium Tetrafluoride was indicated in one of our earlier comunication[1] when the utilization of solar energy had not been reported for the isolation of the compound or its complex. This photolytic method not only eliminates the use of foreign substances used for the purpose of reduction but also minimizes many of the operations involved in other processes of preparation. Of all the common compounds of uranium, advantage has been taken of the use of uranyl formate for the readiness with which it undergoes photolysis in the presence of alcolhol on exposure to bright sunlight giving uranium (IV) compounds. [2-3] Thus when photolysis is carried out in aqueous hydrofluoric acid medium, the tetrafluoride is precipitated. Use of uranyl nitrate also gives the same compound. When, however, photolysis is carried out in the presence of ammonium bifluoride, in place of hydrofluoric acid the complex NH_4F, UF_4, H_2O is obtained which will be published in due course.

EXPERIMENTAL

All the chemicals used were E.Merck, E.P. or G.R. quality. The formate was prepared from the nitrate. When a saturated solution of uranyl formate or nitrate in 38-40 percent. of hydrofluoric acid with half its volume of alcohol was exposed to sunlight in a platinum basin, bright green uranium tetrafluoride began to appear in about 15 minutes time. On further exposure, more of the compound was formed and settled down. The supernatant liquid was decanted off, and the precipitate was washed with aqueous hydrofluoric acid. The analysis of the compound was undertaken after it was dried for about 3 hours at 100° C. in an air-oven.

The molecular weight was determined by dissolving a weighted quantity of the compound in 8N HC1, precipitating uranium as hydrated oxide with NH_4OH and then heating the hydrate oxide, after filtration to U_3O_8 in a 200 platinum crucible. The filtrate was used for the estimation of fluoride as CaF_2 by Badeeva's[4] method. Uranium (IV) content was estimated by the method adopted by Hatt.[5] When a weighed quantity of the compound was boiled in strong NaOH solution for 15 minutes and filtered, hydrated uranium (IV) oxide remained as the residue and the filtrate contained the fluoride. Uranium was determined by Jones redactor method[6] after dissolving the residue in 6 N. H_2SO_4. The volumetric estimation of the fluoride present in the filtrate was carried out by the modified thorium nitrate method developed in this laboratory.[7] The analytical data recorded in Tables I, II.

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TABLE – I

(Molecular Weight – Theoretical 341. Molecular Formula – UF_4, 1.5 H_2O)

Material used for photolysis	Compound taken mg.	U_3O_8 found mg.	Molecular weight calculated	CaF_2	
				Calculated mg.	Found mg.
$UO_2(HCO_2)_2$	173.0	142.8	340	79.1	79.0
	155.5	128.0	341	71.1	70.7
	147.2	121.5	340	67.3	67.0
	131.3	108.0	341	60.1	59.9
$UO_2(NO_3)_2$	158.1	129.8	341.6	72.3	72.8
	134.0	110.2	341.3	61.3	61.0
	140.8	116.2	340.0	64.4	64.1
	183.0	151.0	340.3	83.7	83.5

TABLE – II

Estimation of uranium by Jones Reductor and fluoride by thorium nitrate

Material used for photolysis	Compound taken mg.	Uranium		Fluoride	
		Calculated mg.	Found mg.	Calculated mg.	Found mg.
$UO_2(HCO_2)_2$	160.0	111.7	111.9	35.7	34.9
	197.4	137.8	137.8	44.0	43.7
	181.2	126.5	126.1	40.4	39.8
	192.5	134.3	134.5	42.9	42.3
$UO_2(NO_3)_2$	141.4	98.7	98.8	31.5	31.1
	170.5	119.0	118.8	38.0	37.9
	85.7	59.8	59.6	19.1	18.8
	81.0	56.5	56.4	18.1	18.1

and III show that the compound obtained possesses the formula UF_4, 1.5 H_2O.

TABLE – III
Estimation of uranium (IV) by Hatt's method

Material used for phytolysis	Compound taken mg.	Uranium	
		Calculated mg.	Found mg.
$UO_2(HCO_2)_2$	382.8	267.1	267.6
	274.5	191.6	188.2
	127.0	88.6	89.4
	147.4	102.9	101.6
$UO_2(NO_3)_2$	174.4	121.7	121.0
	168.0	117.2	116.0
	111.0	77.5	77.6
	107.4	75.0	74.8

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SUMMARY

A simple and convenient method of the preparation of uranium tetrafluoride utilizing solar energy has been described. The advantage of this method is that no foreign substance is used for bringing about the reduction of uranium (VI) to uranium (IV) valency state. When a solution of uranyl formate or uranyl nitrate in hydrofluoric acid and alcohol is exposed to sunlight, a bright green precipitate of uranium tetrafluoride settles down. Photolysis under similar conditions using ammonium bifluoride in place of HF gives the complex NH_4F, UF_4, H_2O.

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The Distribution of the Lower Fatty Acids between Water and a Variety of Solvents

(J.Chem Soc., Vol. 278, 1951, pp 1249-1252)

Mansel Davies, Percy Jones,
D. Patnaik & E. A. Moelwyn-Hughes

Abstract: The first page of this article is displayed as the abstract.

The lactone (20mg.) in pyridine (1ml.) and acetic anhydride (0.5 ml.) was set aside for 48 hours at room temperature. The solvent was then evaporated in a vacuum, the residue dissolved in ether, washed until neutral, and dried (Na_2SO_4), and the ether removed. Recrystallisation from methanol gave diamond-shaped crystals (14mg.), m.p. 147-149^{0} not depressed on admixture with the lactone acetate prepared according to Jacobsen's method (loc. cit.).

Preparation of Jacobsen's Lactone. -To oestrone acetate (300mg.; m.p. 125-126^{0}) in acetic acid (3ml.) was added hydrogen peroxide (32.5%; 2ml.), and the solution was kept in the dark at 35^{0} for 72 hours. The reaction mixture was then diluted with water until crystals appeared. After collection and drying, the crystals had m.p. 146-150^{0} (205mg.). recrystallised from methanol, they had m.p. 148-150^{0}, not depressed on admixture with Westerfeld's lactone acetate.

This acetate (140 mg.), dissolved in methanol (4ml.), was treated with potassium hydroxide (1ml.; 10%) and refluxed for 1.5 hours. Subsequently 10 ml. of water were added and the methanol was removed in a vacuum. The precipitate formed on acidification (hydrochloric acid) was centrifuged, washed with water, and dried in a desiccater. Repeated crystallisation from alcohol gave small prisms (90mg.), m.p. 311-313^{0} (decomp.), not depressed on admixture with Westerfeld's lactone, and having $(\alpha)_D^{21}$ + 39.4^{0} $\pm$ 4$^{\alpha}$ (c,0.762 in pyridine).

We thank the Medical Research Council for a maintenance grant for one of us (M. K.) and the Norther Council of the British Empire Cancer Campaign for financial support.

UNIVERSITY OF DURHAM, KING'S COLLEGE,
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(Received, January 31st, 1951.)

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A Brief Report on: Professor Dayanidhi Patnaik Birth Centenary Memorial Symposium

Dr. Debasis Mohanthy

11th July 2018
Department of Chemistry
Autonomous Science College, Dhenkanal, Odisha

A one day seminar in honour of Prof. Dayanidhi Patnaik was held at Denkanal Autonomous Science College on 11th July 2018.

The seminar was chaired by the Honourable Principal of the College Dr. (Mrs.) Bijayalaxmi Acharya. Prof. B. Sahoo, Former Professor of Chemistry, IIT Kharagpur & Former President of Orissa Chemical Society and Prof. P. K. Pattnayak, Former Professor of Metallurgy and Materials Science, IIT Bombay attended as guests of honour . Prof. C. S. Panda, Former Professor of Chemistry, Berhampur University, Odisha & Former President of Orissa Chemical Society; Prof. A. C. Dash, Former Professor of Chemistry, Utkal University, Bhubaneswar & Former President of Orissa Chemical Society and Dr. C. R. Mishra, Former Deputy General Manager & Head (R & D) Nalco, Bhubaneswar & Former President of Orissa Chemical Society attended as distinguished speakers.

Prof. Sahoo gave a vivid account on the life and works of Prof. Dayanidhi Patnaik. Prof. Dayanidhi Patnaik was a great teacher and reputed scientist. His research work at University of Cambridge, UK on "Effect of Light on the Combustion of Hydrocarbons" and at Ravenshaw College, Cuttack on (a) Ion-Solvent Interactions (b) Chemical Kinetics (c) Chemistry of Rare-Earths and Uranium Compounds has profoundly influenced the future research work and has dramatically furthered the understanding on the deeper aspects of the subjects.

Prof. Pattnayak highlighted on his patriotic spirit and his invaluable contributions to the Sarvodaya Movement led by Acharaya Vinoba Bhave. He was a Ghandian in spirit and strongly believed that sustainable development can only be achieved by adopting Ghandian thought of progress. Dr. C. R. Mishra explained to the students on the application of Science for technological progress with great clarity. Prof. C.S. Panda described the importance of Tri-arylbutazole- 1,2-Diketone and the novel route he followed for its synthesis. Prof. A. C. Dash described the greatness of Prof. Dayanidhi Patnaik in achieving great things using simple methods and ideas. He gave several examples from Dr. Patnaik's works in order to make a permanent mark in the minds of young students.

There was a good deal of interaction between the students and the guests on various aspects of Science and Human Development.

Finally, Dr. Debasis Mohanthy gave the vote of thanks.

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Symposium in Session

From left to right: Dr. Debasis Mohanty, Prof. A. C. Dash, Prof. P. K. Pattnayak, Prof. B. Sahoo, Dr. (Mrs.) Bijayalaxmi Acharya (Principal), Dr. C. R. Mishra & Prof. C. S. Panda on the dias.

Prof. P. K. Pattnayak delivering his talk

Prof. B. Sahoo highlighting outstanding contributions of Prof. D. Patnaik in the field of Chemistry

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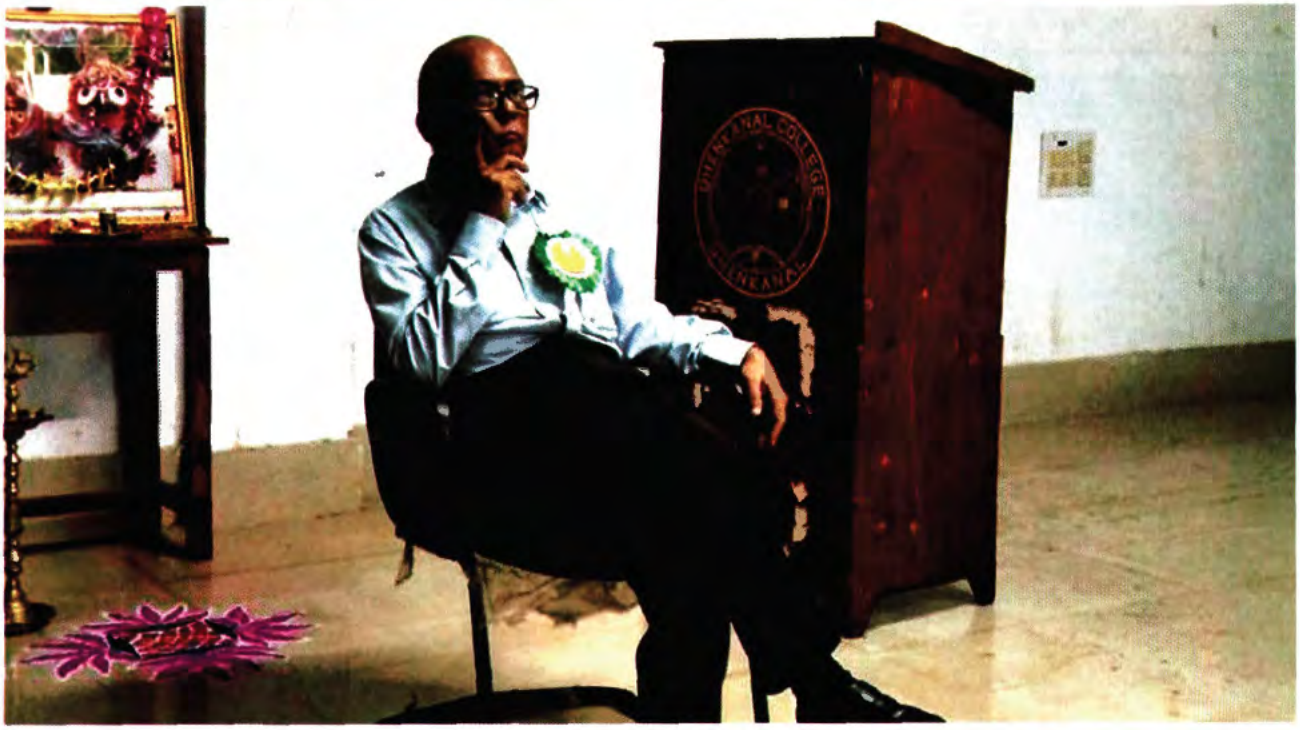
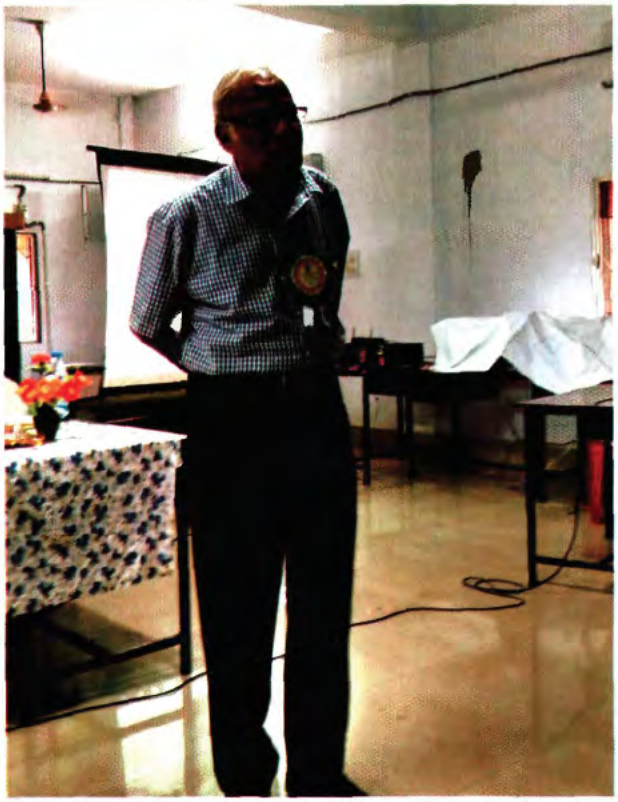
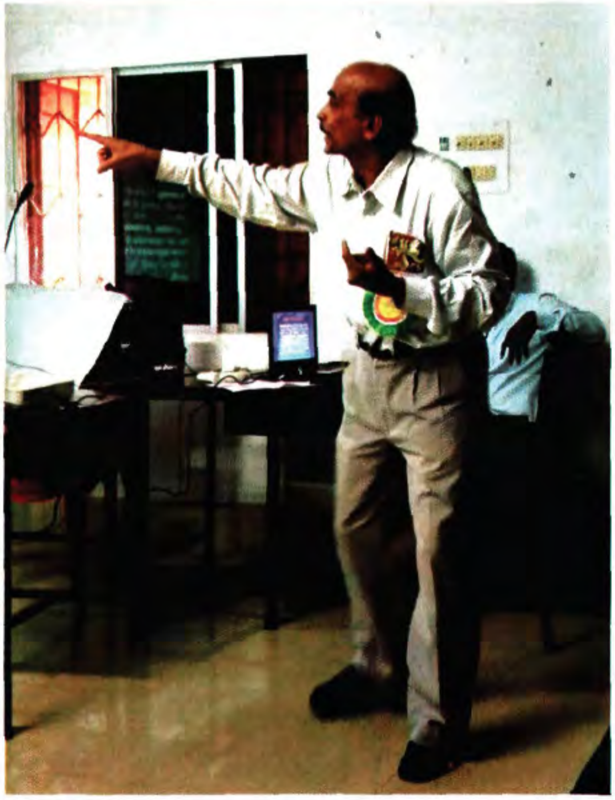


Prof. A. C. Dash delivering his talk



Prof. C. S. Panda addressing to the students



Dr. C. R. Mishra explaining the role of science in technological developments

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A Brief Report on: Professor Dayanidhi Patnaik Birth Centenary Memorial Symposium

Dr. Jaya Prakash Das

12th September, 2018
Department of Chemistry, Ravenshaw University, Cuttack

The Department of Chemistry, Ravenshaw University is celebrating the Birth Centenary of Professor Dayanidhi Patanaik, (1918-1985) an illuminating educationist of the post independence era, a dedicated teacher and an inspiring researcher, on 2nd November 2018. As a part of the year long celebration, the Department of Chemistry organized a one day symposium "***Professor Dayanidhi Pattnaik Centenary Memorial Symposium***" on **12th September 2018**.

The Inaugural Function started at 11 AM in the morning with a Welcome Address by Dr. Jaya Prakash Das, HOD Chemistry. Prof. Balaram Sahoo, Chairman, Dr. Dayanidhi Patnaik Memorial Trust and Prof. Prasant Kumar Pattnayak, Managing Trustee of the Memorial Trust were present during the meeting and spoke on the life and works of Prof. Dayanidhi Patnaik. Prof. Anadi Charan Dash, Prof. C. S. Panda, Prof. A. Samantray, President, Orissa Chemical Society, Prof. Subasini Lenka, and Dr. Chitta Ranjan Mishra also gave a brief account on the life and works of Prof. Dayanidhi Patnaik. The meeting culminated with a formal vote of thanks by Dr. Bairagi Charan Mallick, Organising Secretary of the Symposium.

The Technical Session started at 12 noon. Dr. Moloy Sarkar, Associate Professor, School Chemical Sciences, NISER, Bhubaneswar gave a lecture on **"Understanding the Behavior of Some Important Liquid and Solid Materials through Fluorescence"** followed by Poster Session and lunch. There were a total number of 15 posters presented by research scholars (M.Phil. and Ph.D. students).

The Post Lunch Session started at 3 PM. Dr. Padmaja Prasad Mishra, Associate Professor, Chemical Sciences Division, Saha Institute of Nuclear Physics, Kolkata gave a lecture on **"Breathing Dynamics at the DNA Bubble: Monitoring One Molecule at a Time"**. It was a great learning experience for M.Sc. & Ph. D. Students and certainly for all of us. Members of the Chemical Society, Under Graduate and Post Graduate Students of the Department, Faculty Members, Members of Ravenshaw Chemistry Alumni Association, Invited Guests, Delegates & others participated in the Symposium in large numbers and made it a grand success.

Head, Department of Chemistry
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Dr. J. P. Das, HOD, Chemistry, Ravenshaw University delivering his address.

Members of the audience engrossed with the talk.

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Symposium in Progress.

Prof. Balaram Sahoo, Chairman, Dr. Dayanidhi Patnaik Memorial Trust delivering his speech.

Invited Guests, Former Presidents of Orissa Chemical Society and Faculty Members of the Dept.

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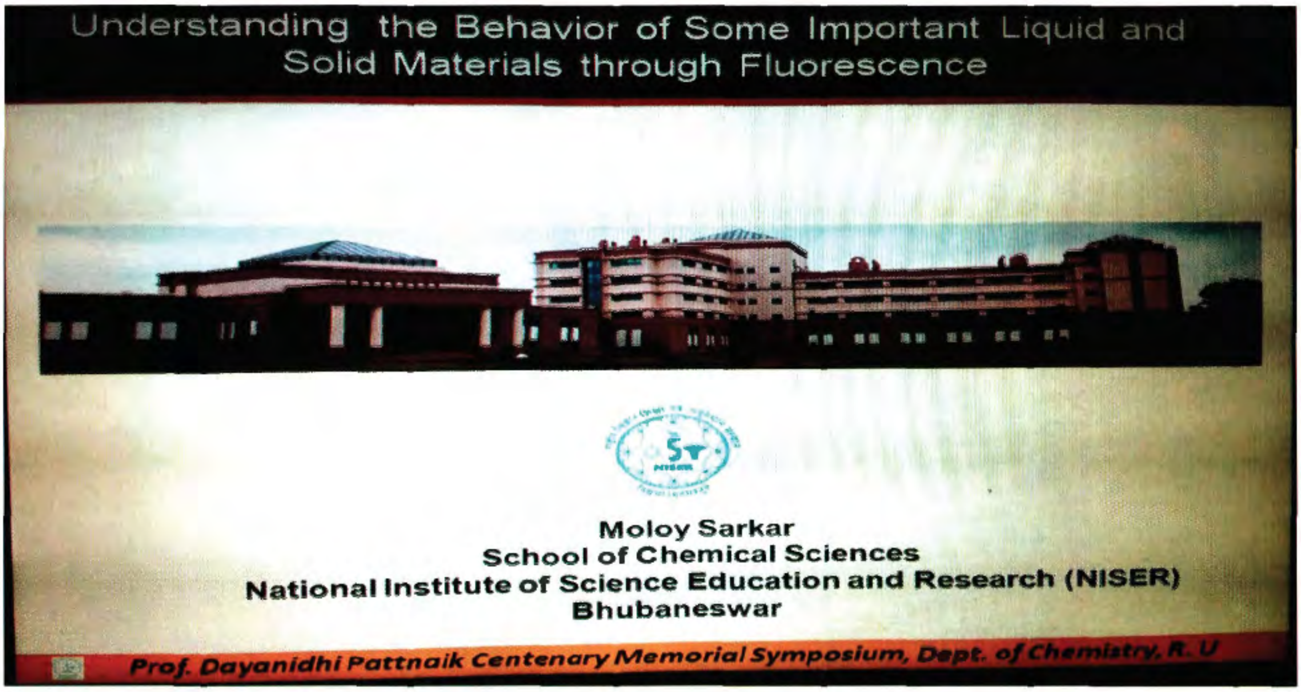
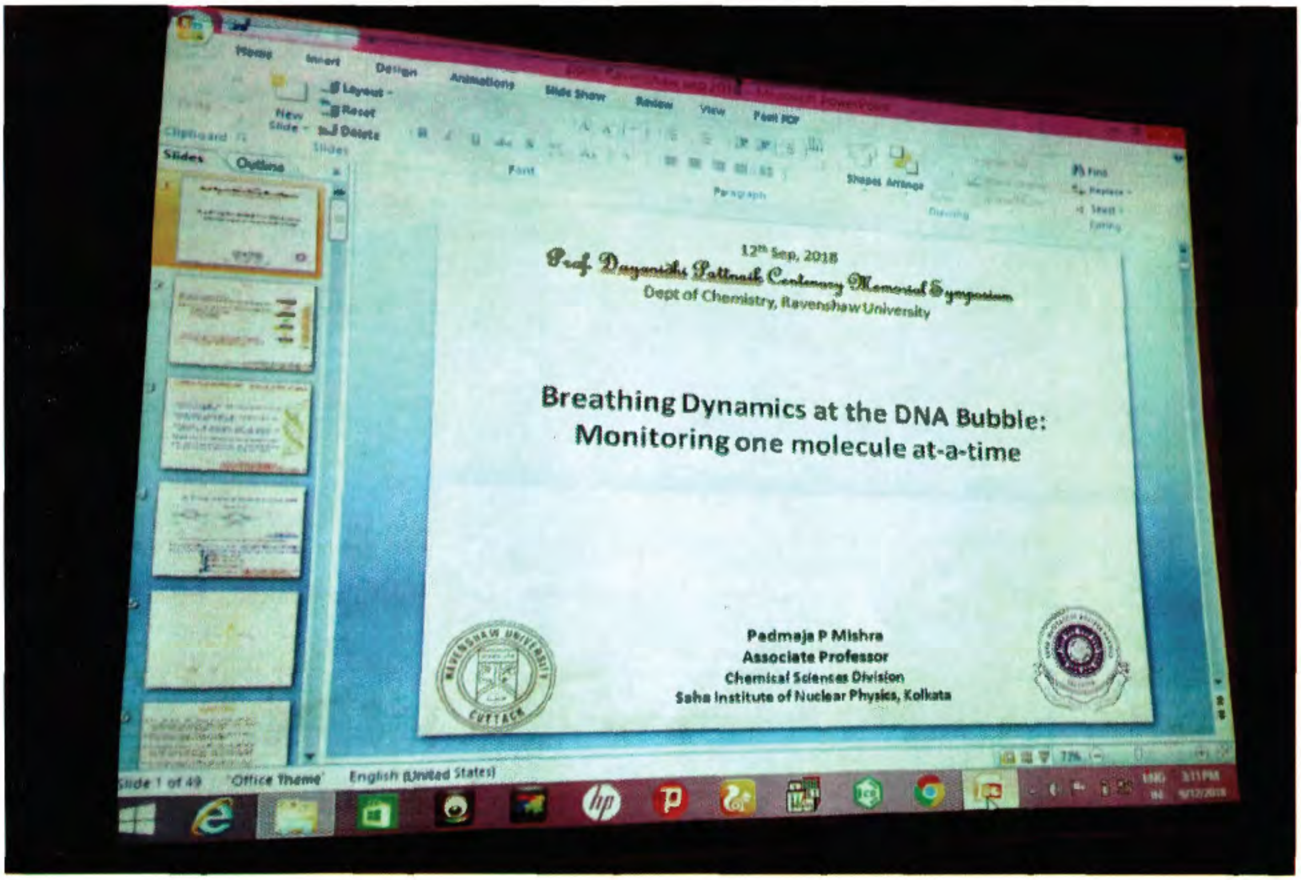
Scientific Presentations: Invited Talks





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Poster Presentations

Microwave Assisted Rapid and Efficient Synthesis of New Series of Chromene based 1,2,4-Oxadiazole Derivatives and Evaluation of Antibacterial Activity with Molecular Docking Investigation

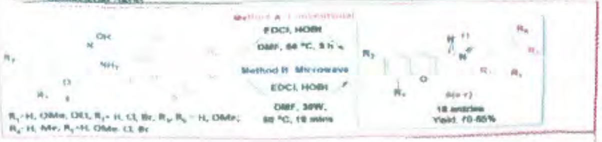
Nilofar Baral,[1] Seetaram Mohapatra,*[1] Bishnu Prasad Raiguru,[1] Nilima Priyadarsini Mishra,[1] Pravati Panda,[1] Sabita Nayak[1]
[1]Department of Chemistry, Ravenshaw University, Cuttack, Odisha, India, 753 003
Dr.Seetaram Mohapatra Email id. Seetaram.mohapatra@gmail.com

ABSTRACT

A new series of novel chromene based oxadiazole derivatives were synthesized from a variety of chromene based amidoximes with readily available carboxylic acids under conventional oil bath heating using commercially available EDCI and HOBt as coupling reagents in DMF as well as under microwave irradiation resulting with high yields and purities in an expeditious manner. The structure of the product was ascertained by X-ray crystallographic analysis. All the synthesized compounds were tested for *in vitro* antibacterial activity against two different pathogenic bacteria *i.e. Escherichia coli* (MTCC614) and *Pseudomonas aeruginosa* (MTCC4031).The result indicated that **6g** and **6h** exhibited good antibacterial activity nearer to the standard Gentamicin. The molecular docking studies showed that compounds **6g** and **6h** showing hydrogen bonding interaction with the bacterial target DNA gyrase of *E.coli*.

INTRODUCTON

Currently, bacterial infections has becoming increasingly important global problem. The widespread use of antibacterial agents considered as the leading weapons used for the treatment of infectious diseases resulted in resistance to drug therapy against bacterial infections resulting serious health hazards[1]. So the increasing clinical importance of drug-resistant microbial pathogens has lent additional urgency in microbiological and antifungal research.[2] For a long period of time natural products are still one of the major sources of new antibacterial agents.[3] From literature survey, it was apparent that 1,2,4-oxadiazoles have drawn considerable attention due to their interesting and diverse clinical applications such as antibacterial.[4,6] On the other hand 2H-chromenes are key structural units of a variety of biologically important compounds, have been discovered as a promising lead of potent antimicrobial agent.[5] The activities of chromene as well as oxadiazoles lead us to embark both the pharmacophores in a single frame work and to synthesize a set of 2H-chromene substituted 1,2,4-oxadiazole derivatives and to study its antibacterial activity.



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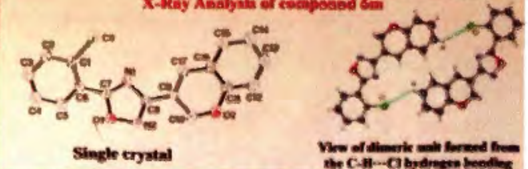
X-Ray Analysis of compound 6m



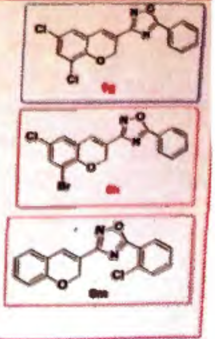
Single crystal

View of dimeric unit formed from the C-H---Cl hydrogen bonding

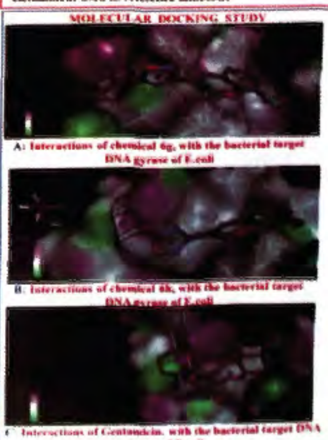
ANTIBACTERIAL ACTIVITY

Serial No	Tested Compound & Code	Diameter of inhibition zone in mm at different concentrations in μg/ml					
		E. coli (MTCC614)			P. aeruginosa (MTCC4031)		
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	6a	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	6b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	6c	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	6d	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	6e	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	6f	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	6g	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	6h	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	6i	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	6j	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	6k	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	6l	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	6m	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	6n	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	6o	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	6p	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	6q	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	6r	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Gen*		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Gentamicin used as reference antibiotic



MOLECULAR DOCKING STUDY



A: Interactions of chemical 6g, with the bacterial target DNA gyrase of E.coli

B: Interactions of chemical 6h, with the bacterial target DNA gyrase of E.coli

C: Interactions of Gentamicin, with the bacterial target DNA gyrase of E.coli

Escherichia coli target (PDB ID:1KZN)

Pseudomonas aeruginosa target (PDB ID:2XCT)

Chemical	Docking score	
	PDB ID:1KZN	PDB ID:2XCT
6g	[illegible]	[illegible]
6h	[illegible]	[illegible]
Gentamicin	[illegible]	[illegible]

PBD, protein data band

CONCLUSIONS

Among all the synthesized molecules, in particular compound **6g** and **6h** was identified as the most potent antibacterial activities against *E.coli*. Through molecular docking study it was noticed that the most potent compounds **6g** and **6h** selectively binds to the DNA of the target bacteria. Together, gives their potent antibacterial activities, these newly synthesized hybrid molecules can be potentially be developed into useful antimicrobial agents that can prompt future researcher with the aim of obtaining some novel heterocyclic candidates for the potential treatment of bacterial infection.

Acknowledgements: My deep sense of gratitude to my guide Dr. Seetaram Mohapatra and also my special thanks to Dr. J.P. Das (HOD Chemistry) and to the all faculty members of chemistry department. I am thankful to all my lab mates and my colleagues.

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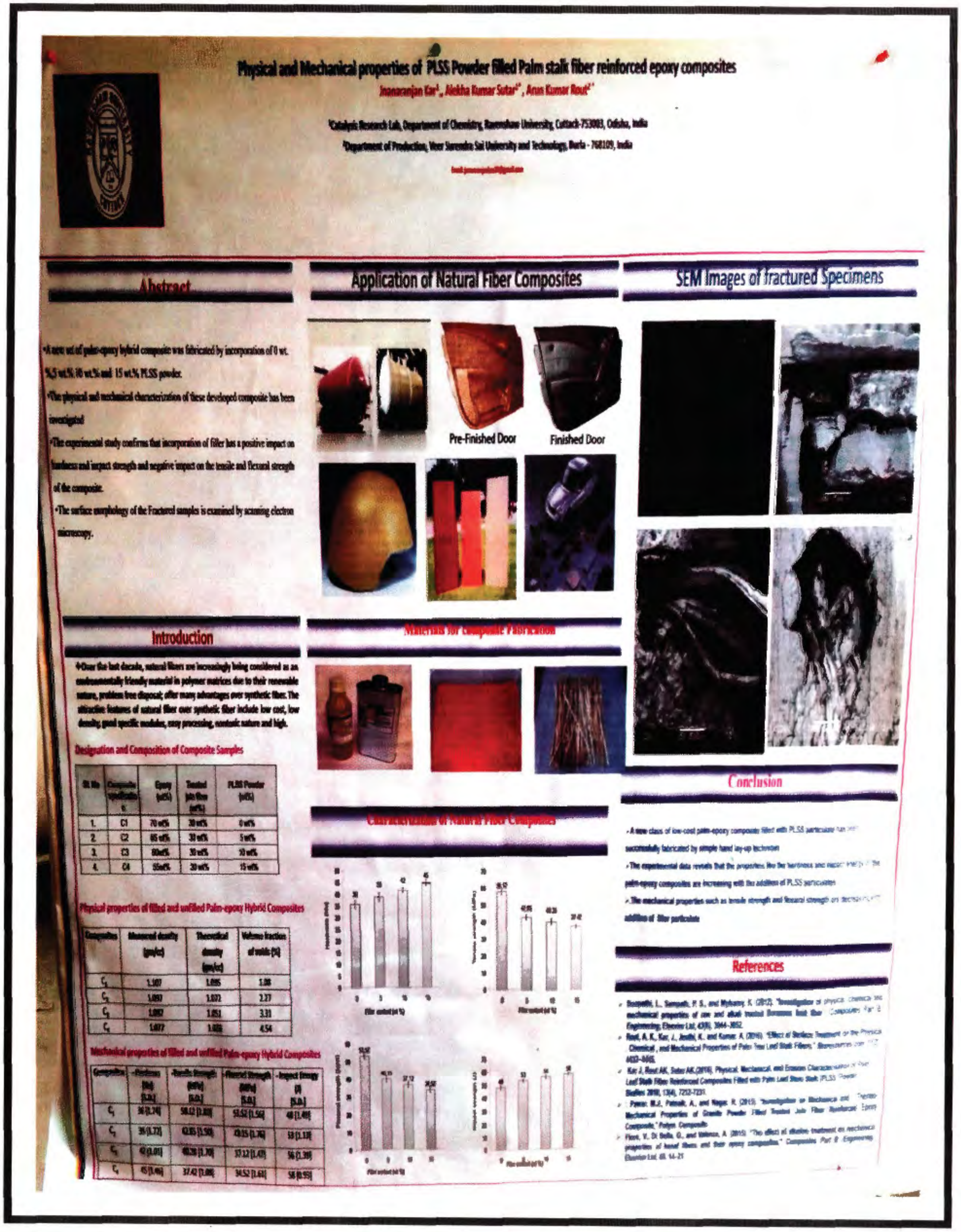

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One pot, Three Component 1,3 Dipolar Cycloaddition: Regio and Diastereoselective Synthesis of Spiropyrrolidinyl Indenoquinoxaline Derivatives

Nilima Priyadarsini Mishra,[1] Deepak Ranjan Mishra,[1] Priyabrata Pattanaik,[1] Pravati Panda,[1] Bishnu Prasad Raiguru,[1] S.K.Shakir,[1] Seetaram Mohapatra,[1*] Sabita Nayak[1]
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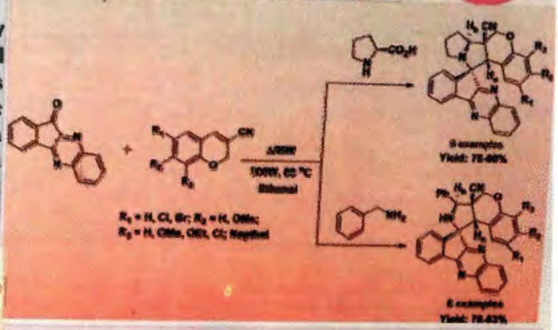
12.09.2018
DEPARTMENT OF CHEMISTRY RAVENSHAW UNIVERSITY

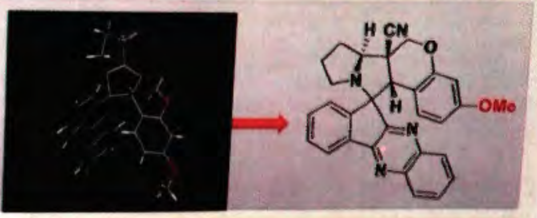
ABSTRACT

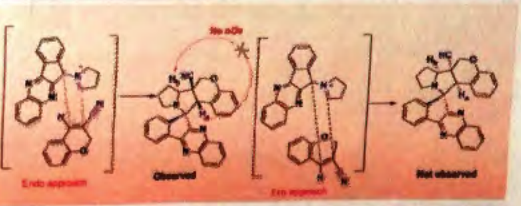
A competent and highly discriminating one-pot synthesis of highly diversified novel functionalized indenoquinoxalone grafted spiropyrrolidine linked chromene-3-carbonitrile conjugates accumulating three pharmocophoric cores, heterocyclic indenoquinoxalone, pyrrolidines and chromene-3-carbonitrile in a single molecular framework by means of 1,3-dipolar cycloaddition reaction between indenoquinoxalone, proline/benzyl amine and chromene-3- carbonitrile in ethanol under classical and microwave conditions is described.



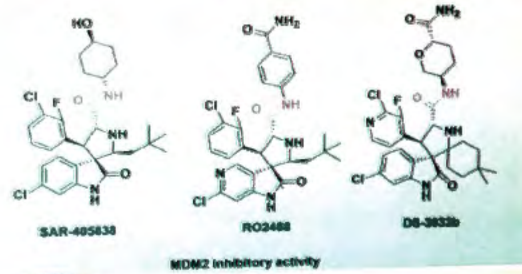
INTRODUCTION

Spiro indenoquinoxaline-pyrrolidines, prepared from 1,3-DC between azomethine ylides with olefinic dipolarophiles, have attracted the increasing interests due to their potentially pronounced biological activities such as acetylcholine esterase inhibitory activity, anticancer, antioxidant, and antitubercular properties.[1-4] The abundance of natural and unnatural bioactive spiroquinoxaline pyrrolizine derivatives have encouraged the design and synthesis of novel spirocyclic indenoquinoxaline with relevant and notable medicinal properties.





BIOLOGICALLY ACTIVE SPIROCYCLIC MOLECULES



CONCLUSION

In summary, we have developed an operationally simple, autocatalytic, one-pot, three component reaction to synthesize new spiro indenoqunoxaline pyrrolidine by employing indenoquinoxalone, proline/benzyl amine and chromene-3-carbonitrile. This is the first report of the preparation of the title compounds by conventional as well as under microwave irradiation in a highly regio- and stereoselective manner.

ACKNOWLEDGEMENTS

I am very much obliged to my Ph.D. Supervisor Dr. Seetaram Mohapatra. I also thankful to Dr. Sabita Nayak for her support. My Sincere thanks to Dr. Jaya prakash Das (HOD, Chemistry) & all the faculty member of Department of Chemistry, Ravenshaw university & my colleagues and friends. Also I thankful to DST –INSPIRE Fellowship for Financial support.

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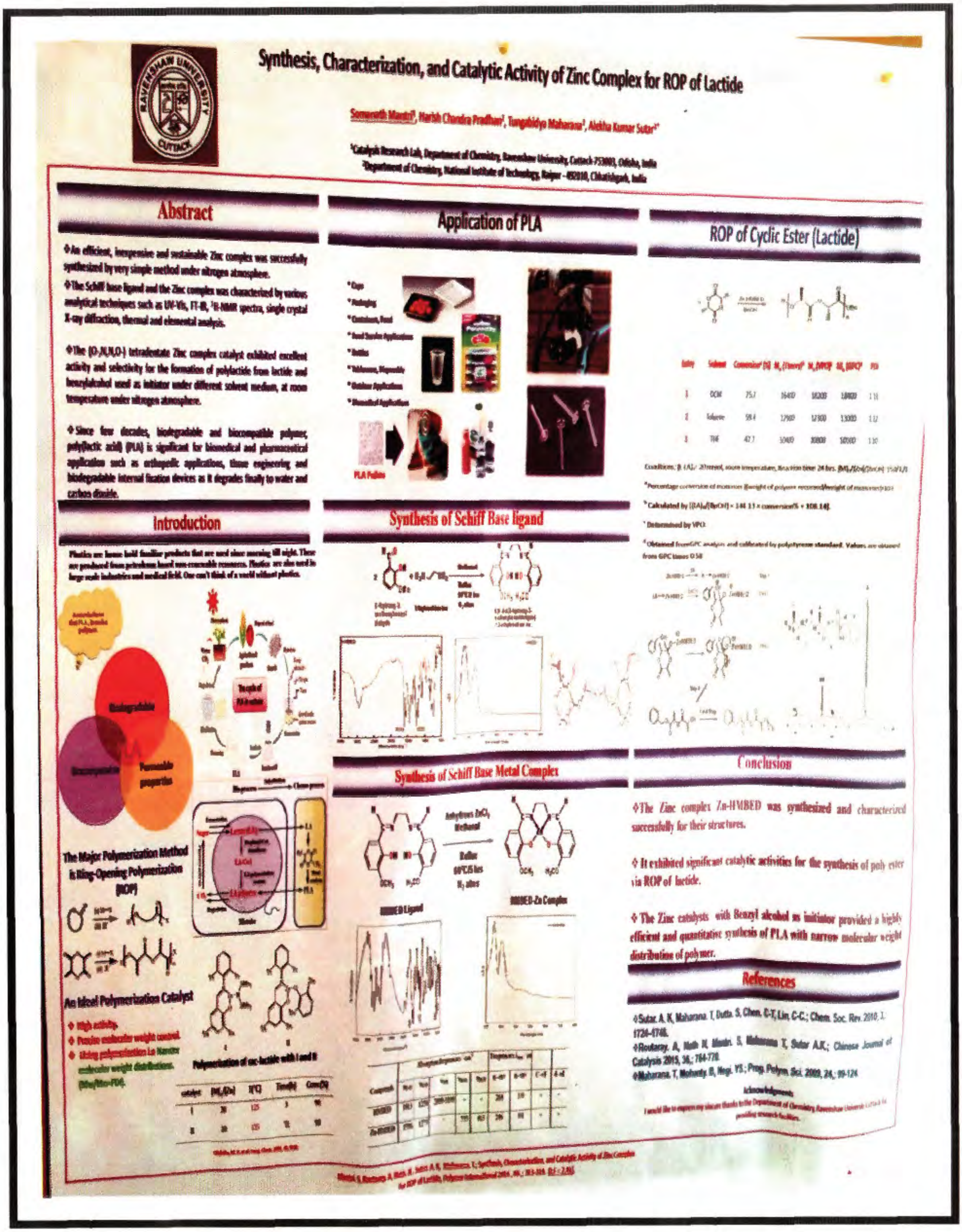

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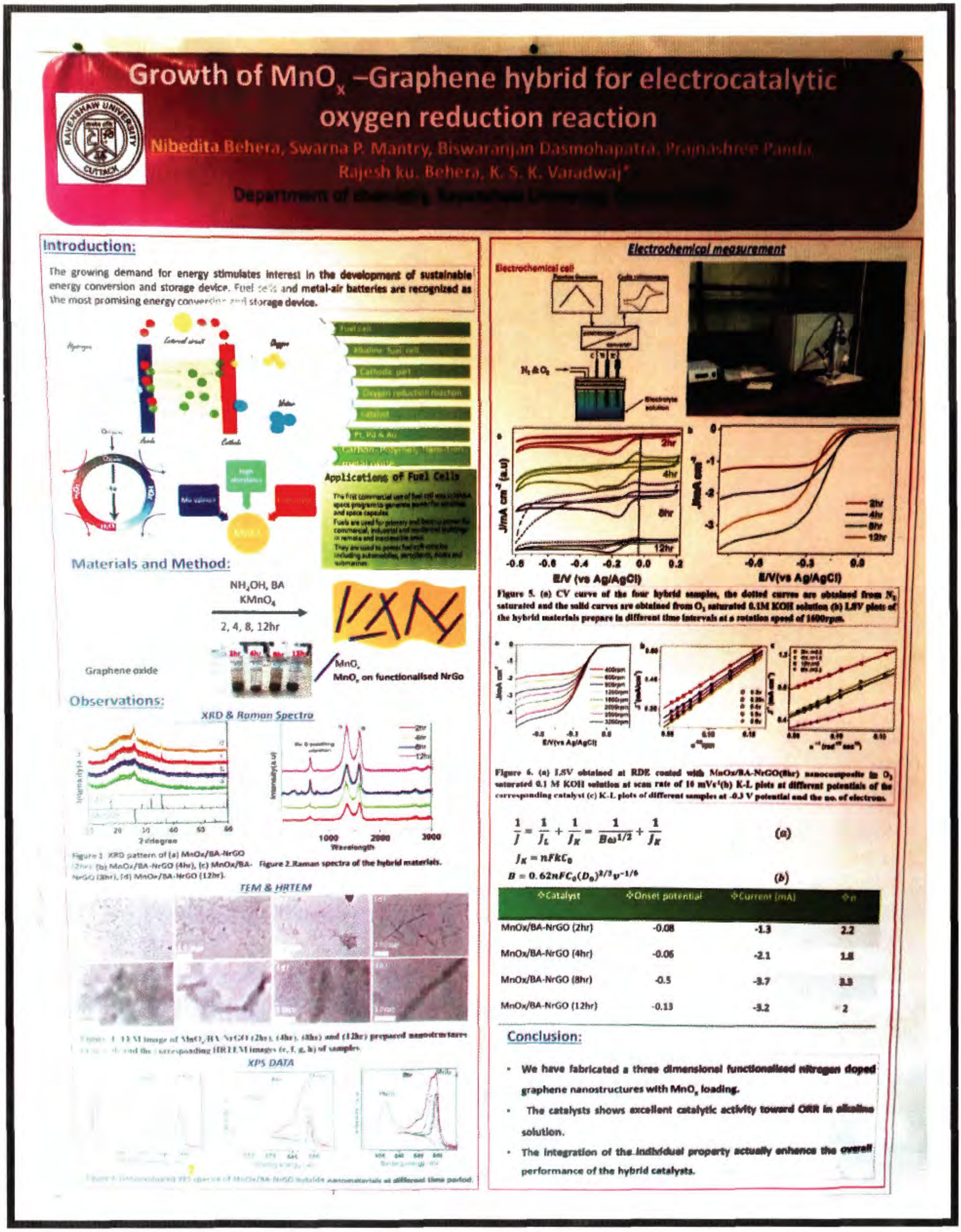

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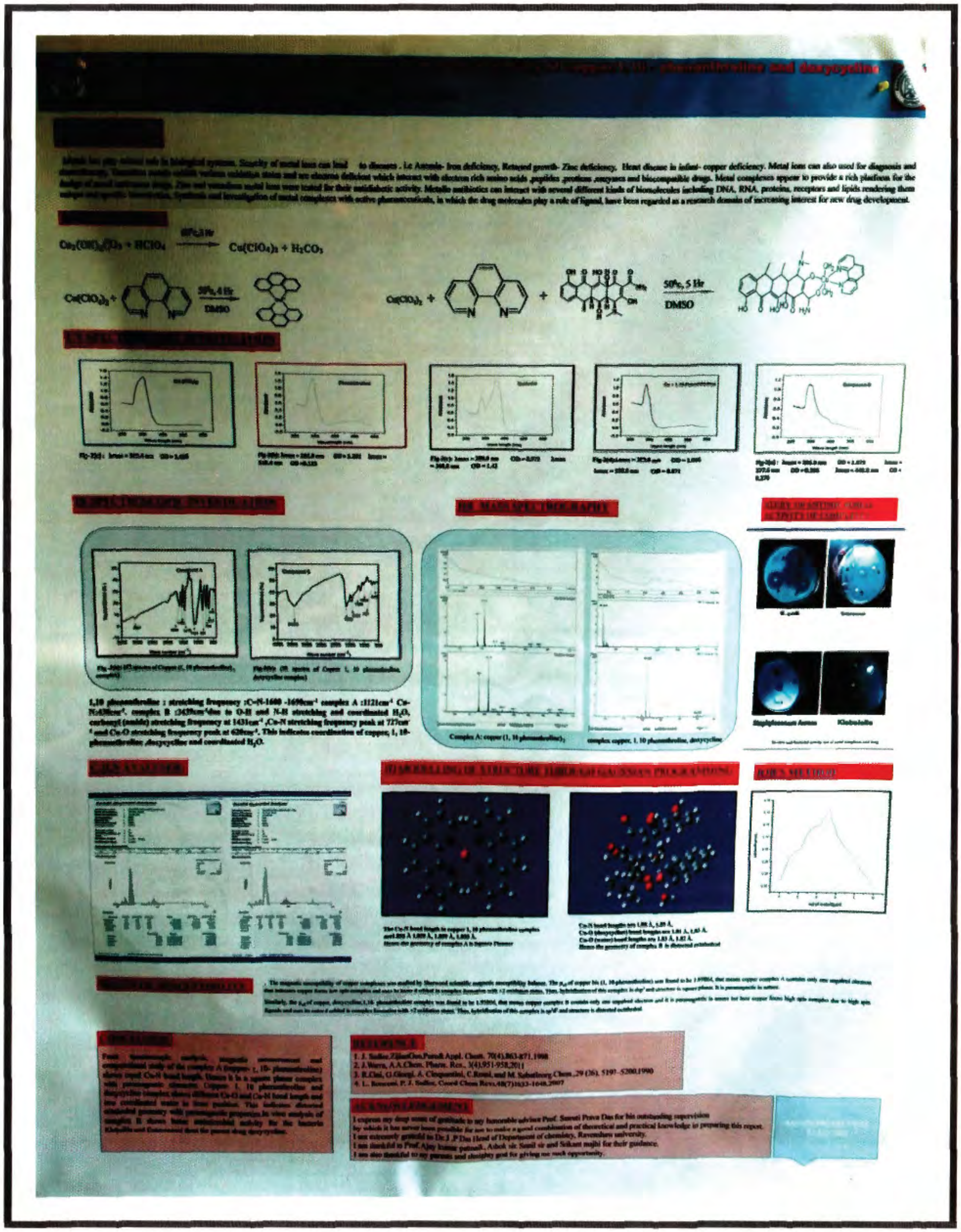

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A Novel Approach to Diastereo- and Enantioselective Claisen Rearrangement

Subhransu Sekhar Pati and Dr. Jaya Prakash Das
Department of Chemistry, Ravenshaw University, Cuttack-753003

Introduction

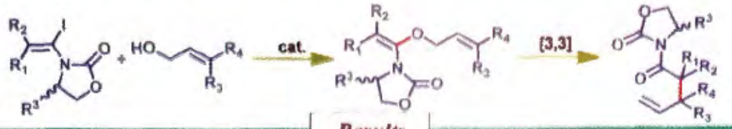
The Claisen Rearrangement is one of the most powerful methods of carbon-carbon bond formation along with the formation of γ-δ unsaturation carbonyl compounds. Since its discovery in 1919, the lack off general process for the stereoselective synthesis of simple allyl vinyl ether for the classical aliphatic Claisen rearrangement has frustrated synthetic chemist. Despite being very well studied the Claisen Rearrangement still possess some limitations: 1) Preparation of suitable allyl vinyl ethers containing a stereogenic centres from simple starting materials. 2) Claisen Rearrangement with high diastereo- and enantioselectivity is a formidable challenge. 3) Construction of a all carbon quaternary stereogenic centre in acyclic system is not only a difficult task but also a challenging one.

Research Goal

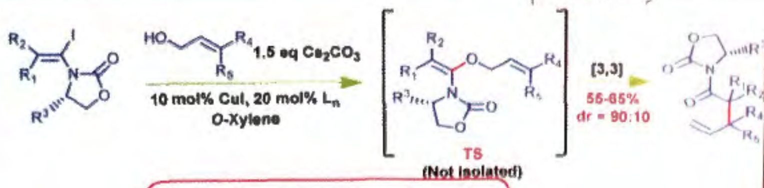
Development and design of a novel domino process that consists of a metal catalyzed C-O bond coupling and a subsequent Claisen Rearrangement with diastereo- and enantioselective products which leads to construction of two adjacent stereocentres along with the desired all carbon quaternary stereocenter.

The Strategy

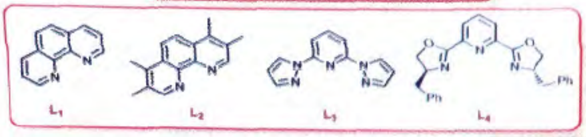
Our proposed path starts from the preparation of allyl vinyl ethers. This could be achieved by carbometallation of simple ynamides which on quencing with iodine provides vinyl iodide species. Treatment on various allyl alcohol on vinyl iodide results allyl vinyl ether. Trnsformation of various allyl vinyl ether into stereoselective Claisen Rearranged product could achieved by chelation controlled copper catalysed pathway.

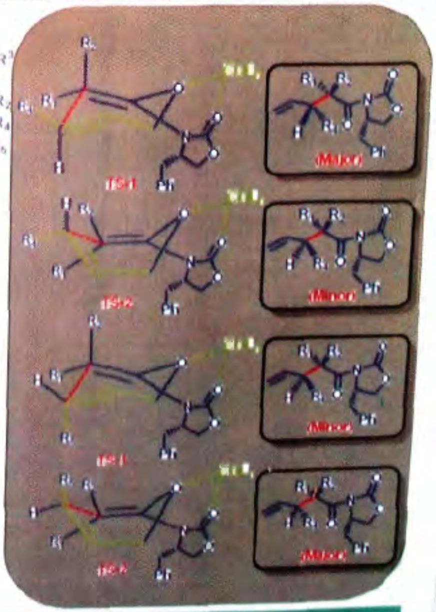


Results



R_1	R_2	R_3	R_4	R_5	L_n
-But	-Et	-H	-Prop	-H	L_1
-But	-Et	-H	-Prop	-H	L_2
-But	-Et	-Bn	-Prop	-H	L_2
-But	-Et	-Bn	-Prop	-H	L_2'
-Hex	-Et	-Bn	-H	-Prop	L_3
-Hex	-Et	-Bn	-Prop	-H	L_3
-But	-Ph	-Bn	-Prop	-H	L_3
-But	-Et	-H	-Prop	-H	L_4





Conclusion:

- In each reaction two new chiral centers (tertiary and quaternary) were formed
- Diastereoselectivity is excellent
- Scope of this reaction is broad: different alkyl groups can be applied
- Simple manipulation of the alkyl groups enables the formation of opposite diastereomers.

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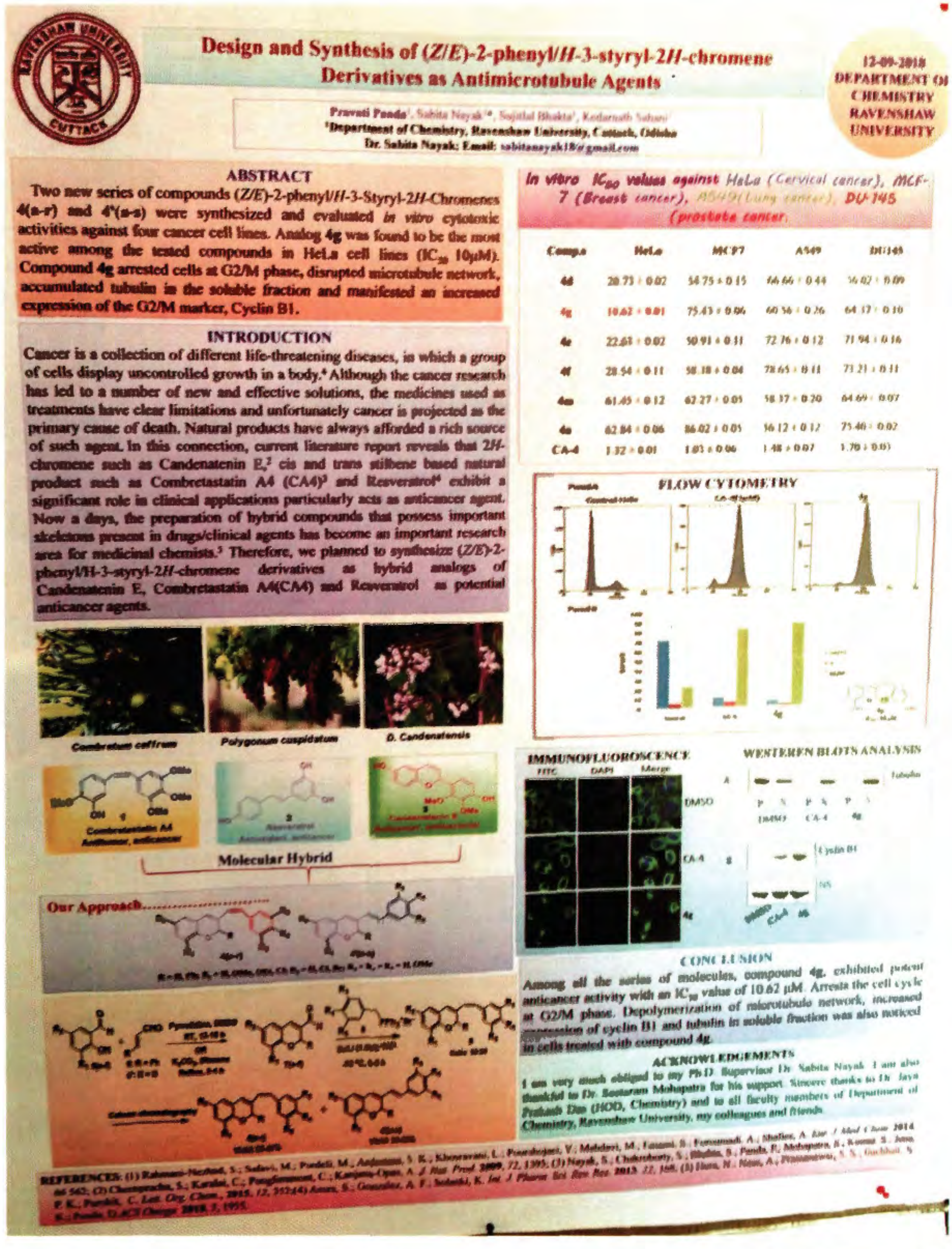

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Assymetric allyboration of aldehydes through Cu catalyzed regiocontrolled hydroboration of ynamides

Subhra Roy, Dr. J. P. Das

Dept of chemistry
Ravenshaw university, cuttack

Introduction:

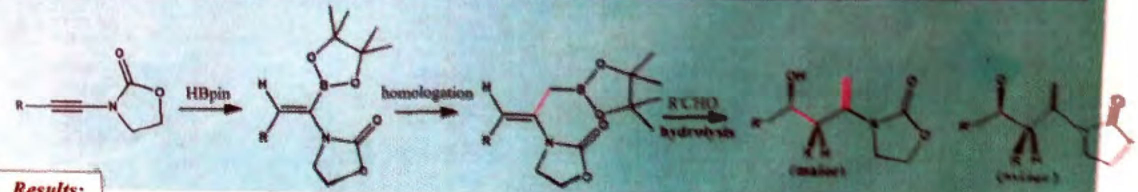
Among the methods of C-C bond formation, assymetric allylboration of aldehydes plays a very important and key role. Their main application in synthesis of stereoselective homoallylic alcohol by allyl transfer to carbonyl compounds are essentially unmatched. In this process new C-C bond formation takes place with two new stereogenic centers created in a predictable controlled manner.

Research Goal:

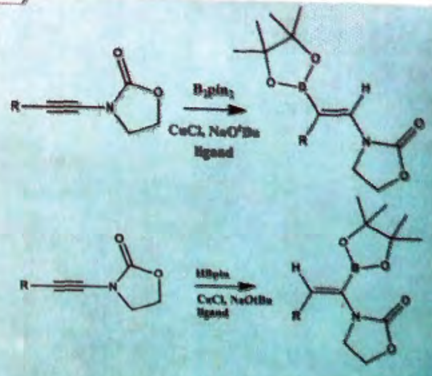
To develop a strategy to synthesize Diasteroselective aldol surrogates trough Cu catalyzed stereoselective hydroboration of ynamides.

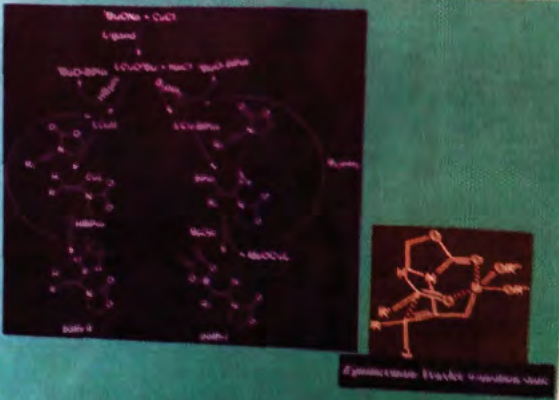
The Strategy:

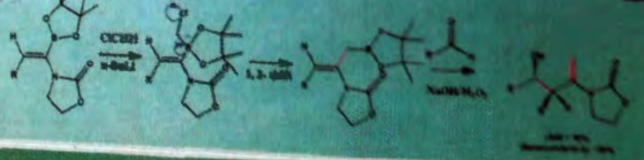
Our strategy is to perform stereocontrolled hydroboration -homologation- aldolization sequence in a single pot reaction, which after hydrolysis leads to a diastereoselective aldol product.



Results:







Conclusion:

- stereocontrolled hydroboration of hetersubstituted alkynes .
- *new C-C bond formation takes place.*
- *Scope of this reaction is broad: different alkyl groups and aldehydes can be applied*
- *Simple manipulation of the alkyl groups enables the formation of opposite diastereomers.*

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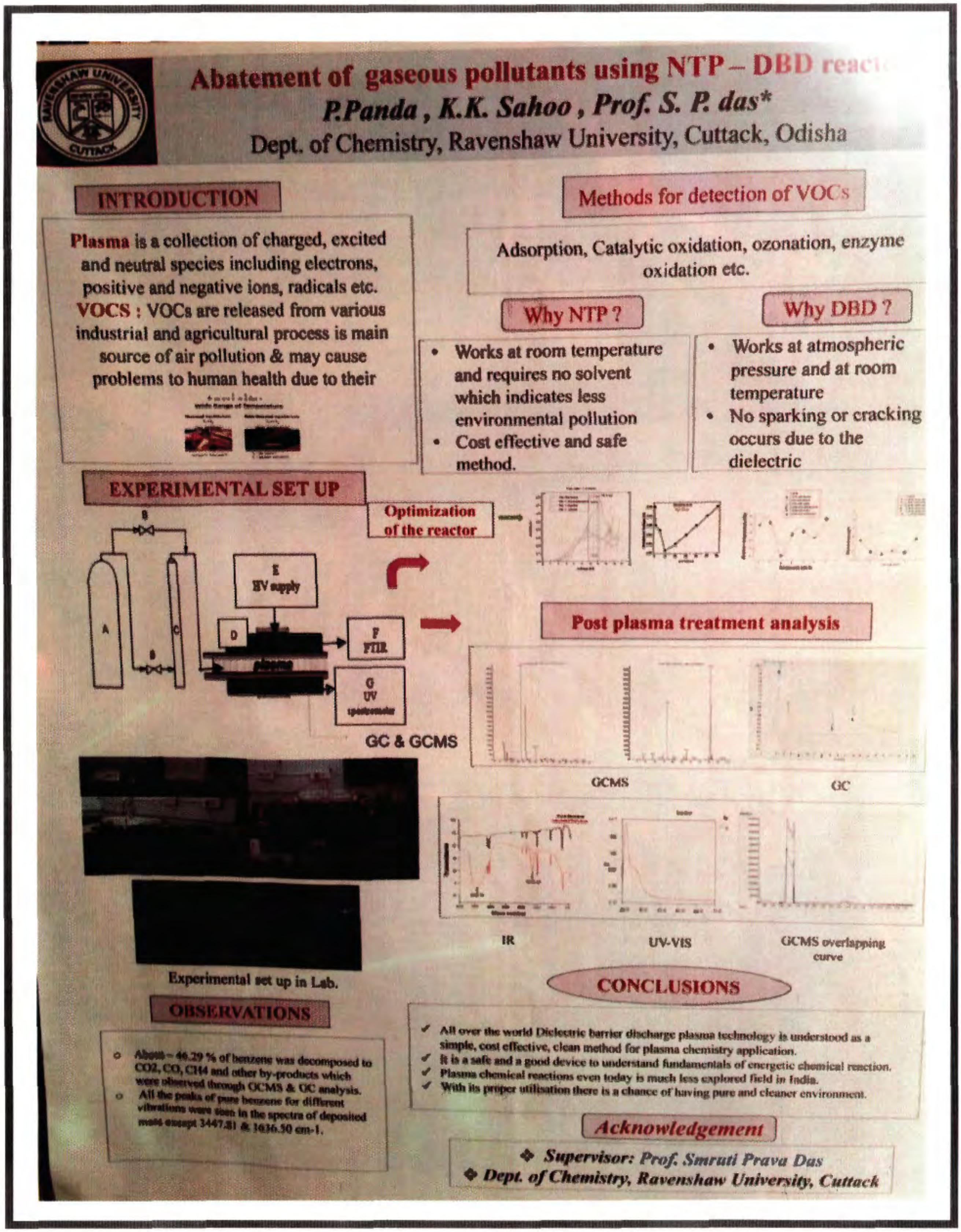

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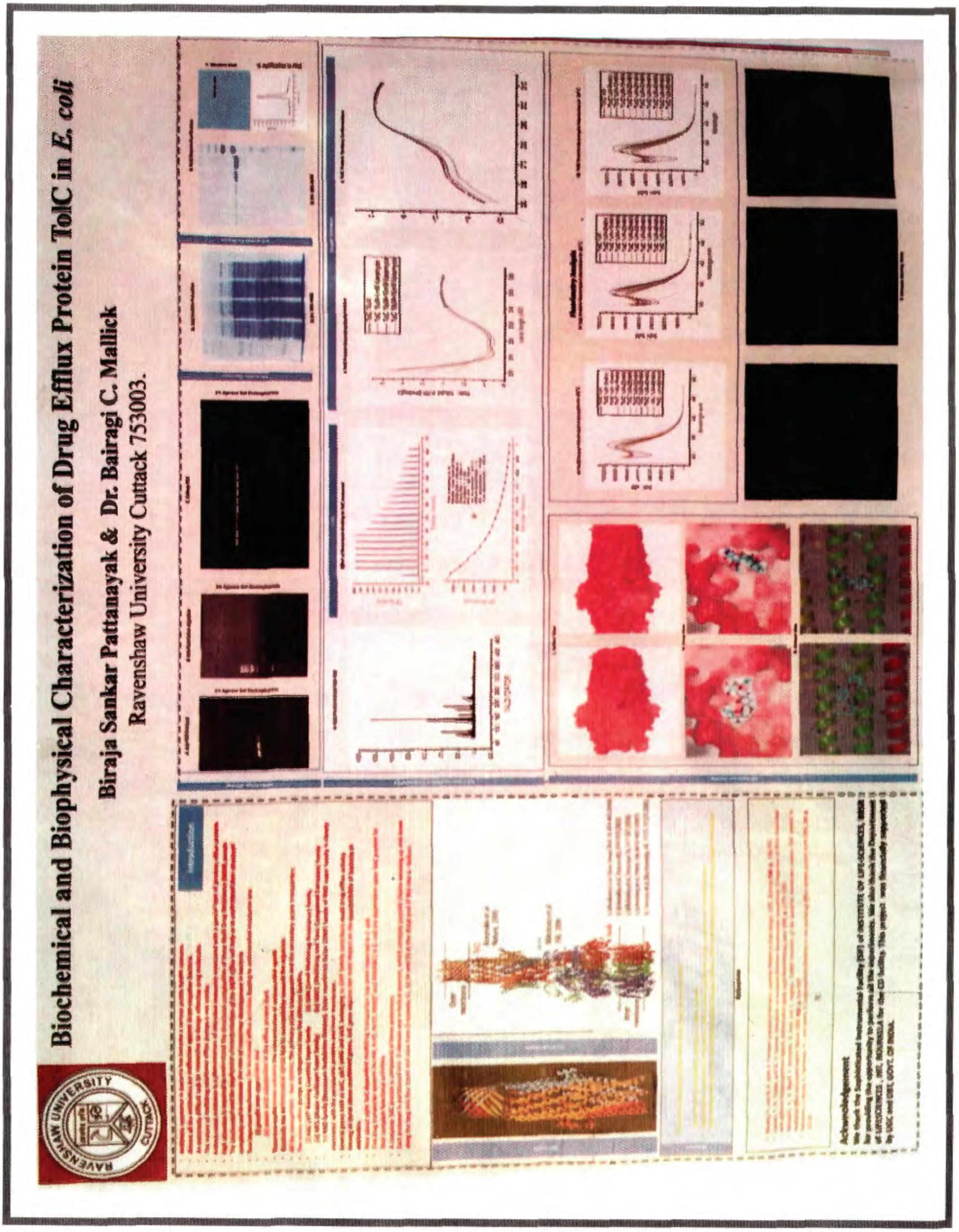

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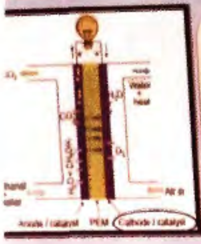
Optimization of ORR Activity of CeO_2 Modified Systems

Ipsha Hota, S. Soren, K.S.K. Varadwaj, P. Parhi*

Department of Chemistry, Ravenshaw University, Cuttack, Odisha, India



Abstract:. To overcome the energy dilemma Oxygen Reduction Reaction (ORR) is one of the major electrocatalytic processes for energy production. However to improve its sluggish kinetics, there is an urgent need to search for efficient electrocatalysts. Carbon materials based system have been widely used as electrocatalysts for ORR in direct methanol fuel cell (DMFCs). First time, we have investigated the activity of CeO_2 embedded in carbon based system (such as $g\text{-}C_3N_4$ and NrGO), to show their preference for 2-electron or 4-electron pathway in ORR process.

Oxygen Reduction Reaction (ORR) at Cathode electro catalyst

4-electron pathway ($O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$)

2-electron pathway($O_2 + H_2O + 2e^- \rightarrow HO_2^- + OH^-$)

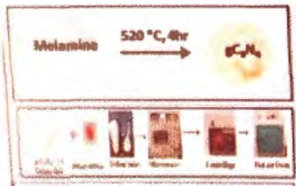
Limitations of Nobel metals

(1) Limited availability
(2) High cost
(3) Long term electrochemical instability
(4) Poor tolerance to fuel molecules

Objective To synthesize **CeO_2 embedded in $g\text{-}C_3N_4$ and NrGO based system** and to evaluate their electrochemical activity.

Expected Outcome

Does this system will be able to replace the Commercial Pt/C ?



Synthesis of gC_3N_4 and $CeO_2/g\text{-}C_3N_4$

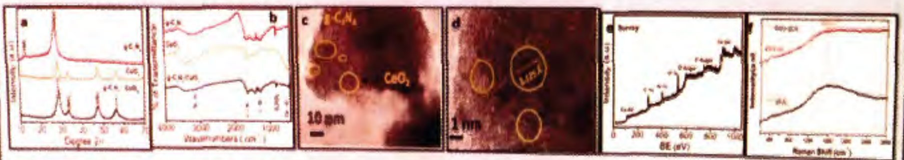
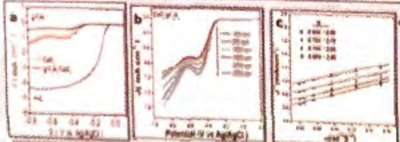


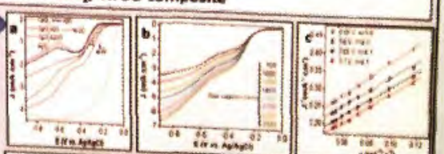
Figure 1(a) XRD, (b) FTIR, (c)TEM, (d) HRTEM, (e) XPS, (f) RAMAN of $CeO_2/g\text{-}C_3N_4$ composite

Synthesis of GO and CeO_2/NrGO

Figure 2(a) XRD, (b) FTIR, (c)TEM, (d) HRTEM, (e) XPS, (f) RAMAN of CeO_2/ NrGO composite



Electrochemical ORR study of $CeO_2/g\text{-}C_3N_4$ Figure 3(a)LSV, (b) RDE, (c) K-L plot



Electrochemical ORR study of CeO_2/NrGO Figure 4 (a)LSV, (b) RDE, (c) K-L plot

$CeO_2/g\text{-}C_3N_4$ composite system is less active for ORR and follows 2-electron pathway, whereas CeO_2/NrGO shows efficient 4-electron pathway. The stability and reaction kinetics of both catalyst was compared.

Acknowledgement:

Ipsha Hota acknowledges DST-SERB (Grant no.EMR/2016/006050) for fellowship.

Schematic of ORR on catalyst surface via different pathways.

Stability and ORR activity comparison of $CeO_2/g\text{-}C_3N_4$ and CeO_2/NrGO Figure 5(a) CV, (b) Choronoamporometry, (c) Methanol Tolerance, (d)RRDE (e) n vs E plot, (f) % of H_2O^- vs E plot

Conclusion

$CeO_2/g\text{-}C_3N_4$ composite system is less active for ORR and follows 2-electron pathway may be due to the nitrogen (C-N-C) involved in triazine rings as active site for ORR, whereas CeO_2/NrGO shows efficient 4-electron pathway may be due to the presence of more active pyridinic and pyrrolic Nitrogen with delocalized lone pair.

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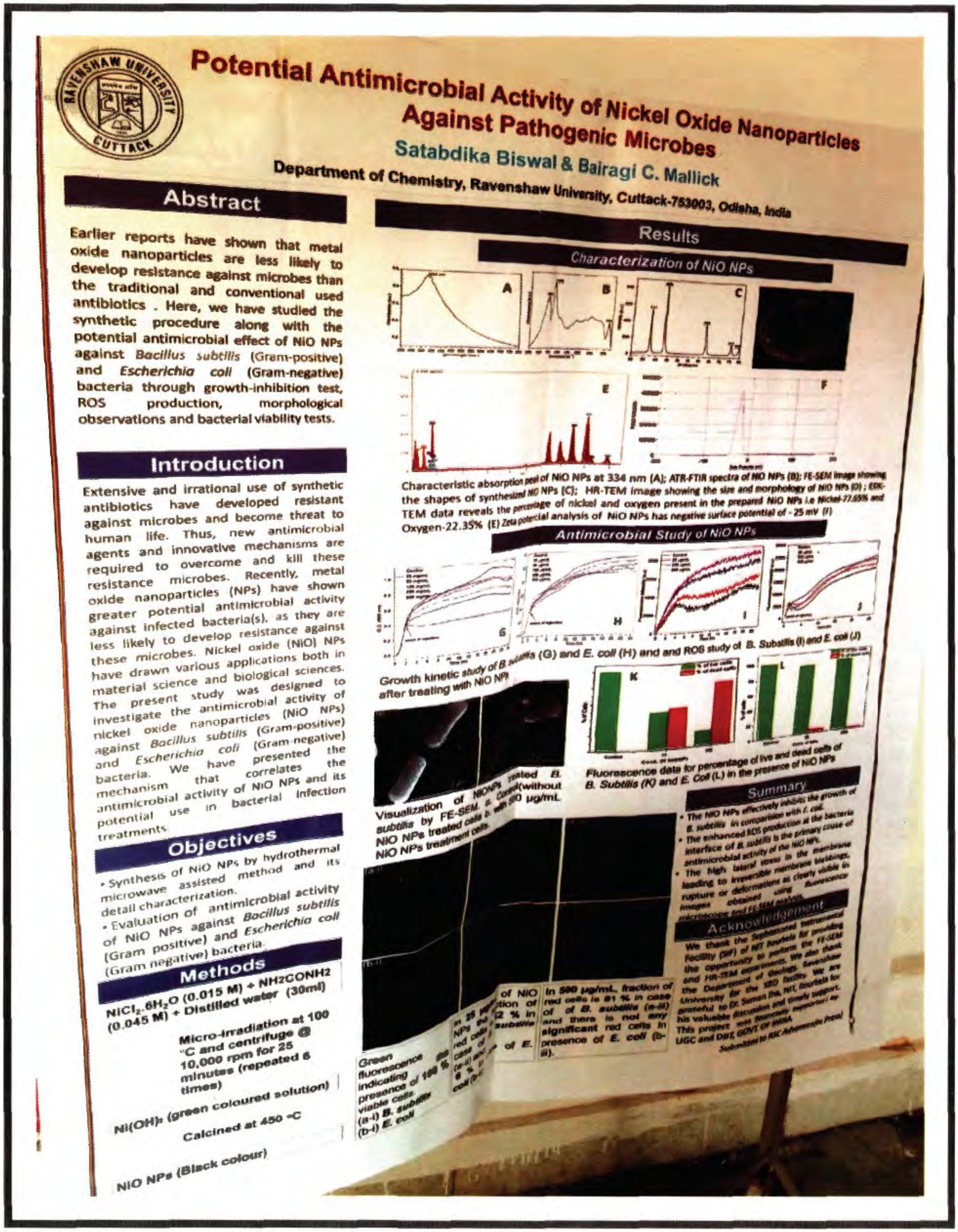

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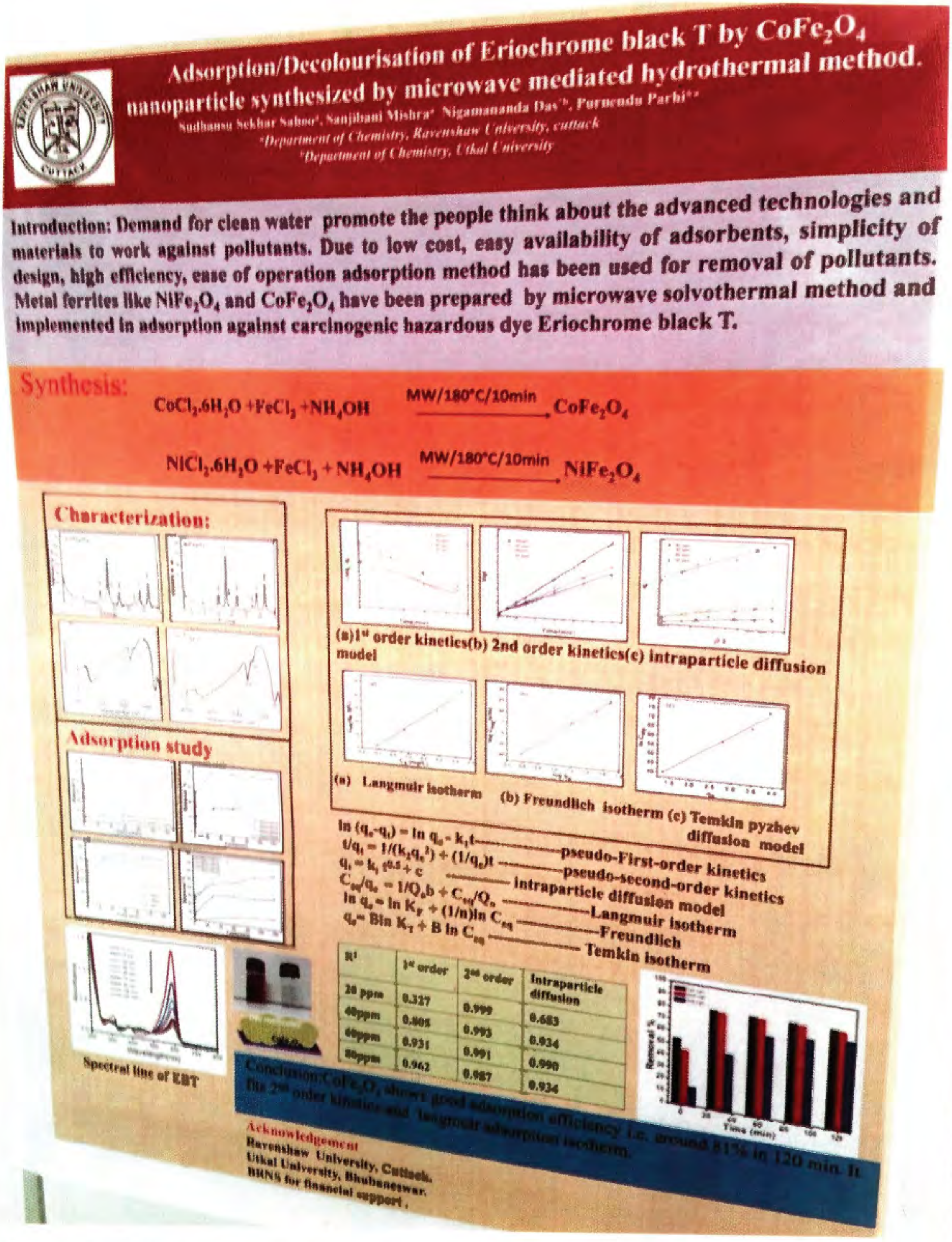

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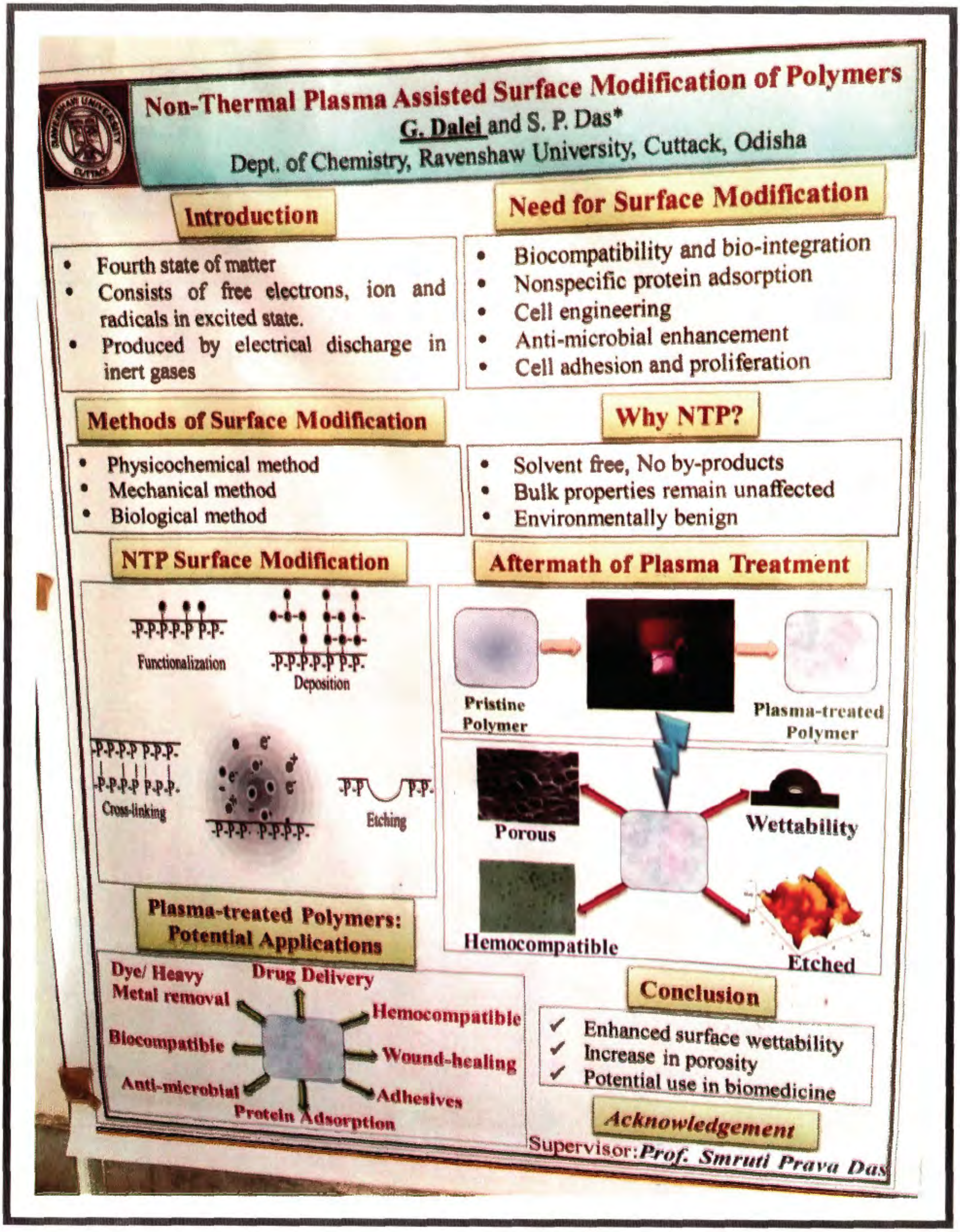

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October 24, 2018

Re: Professor Dayanidhi Patnaik Birth Centenary Celebration

Dear Professor Pattnayak,
Dear Professor Samantaray,

Thank you for your kind letter of invitation to attend the celebration of Professor Dayanidhi Patnaik's birth centenary. I am honoured that you considered me for this prestigious occasion.

I regret to say that due to existing travel arrangements, I will be unable to join you in what promises to be a great celebration.

My best wishes for the success of the event.

Professor John Pyle
1920 Professor of Physical Chemistry

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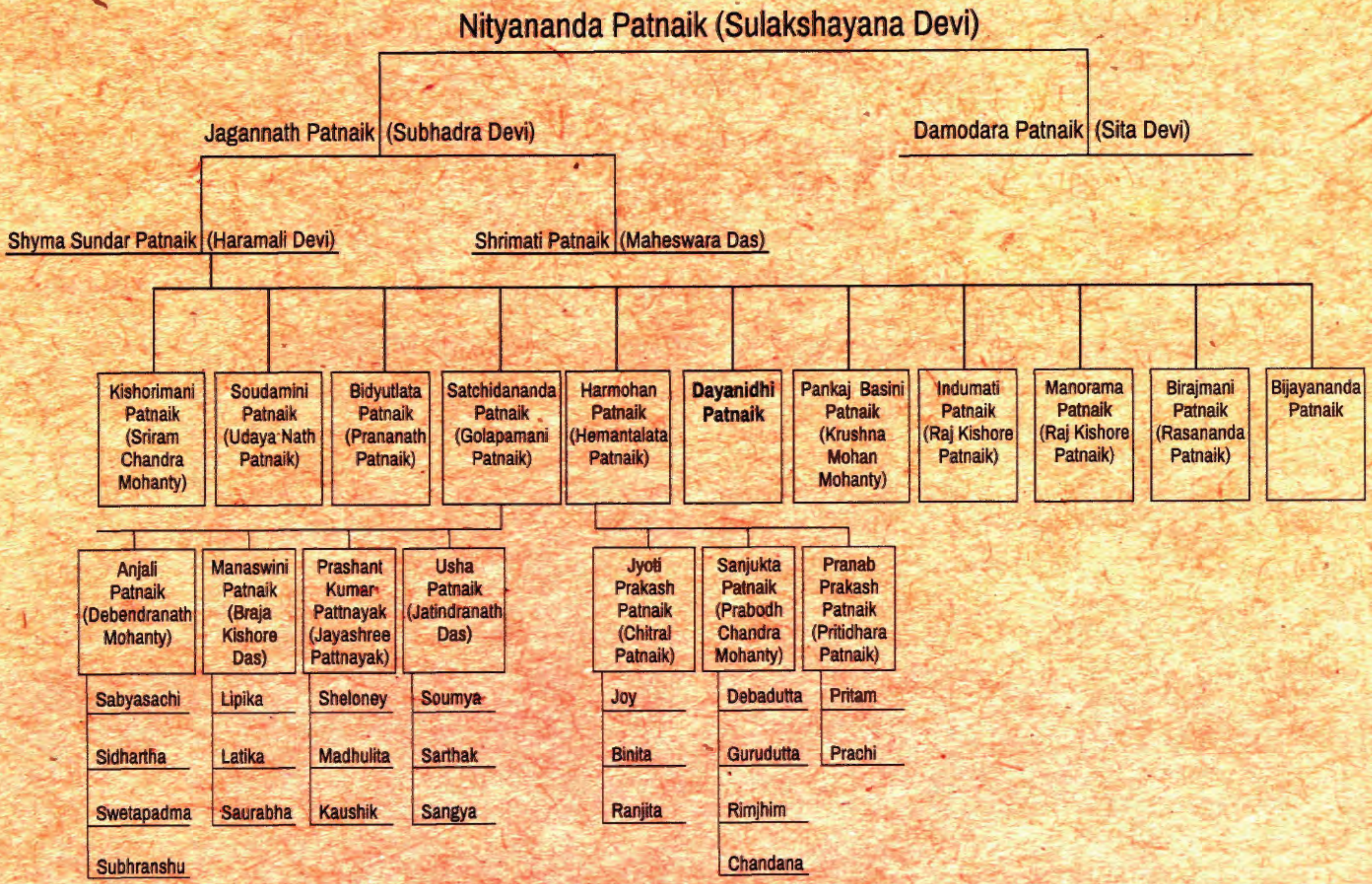
FAMILY TREE



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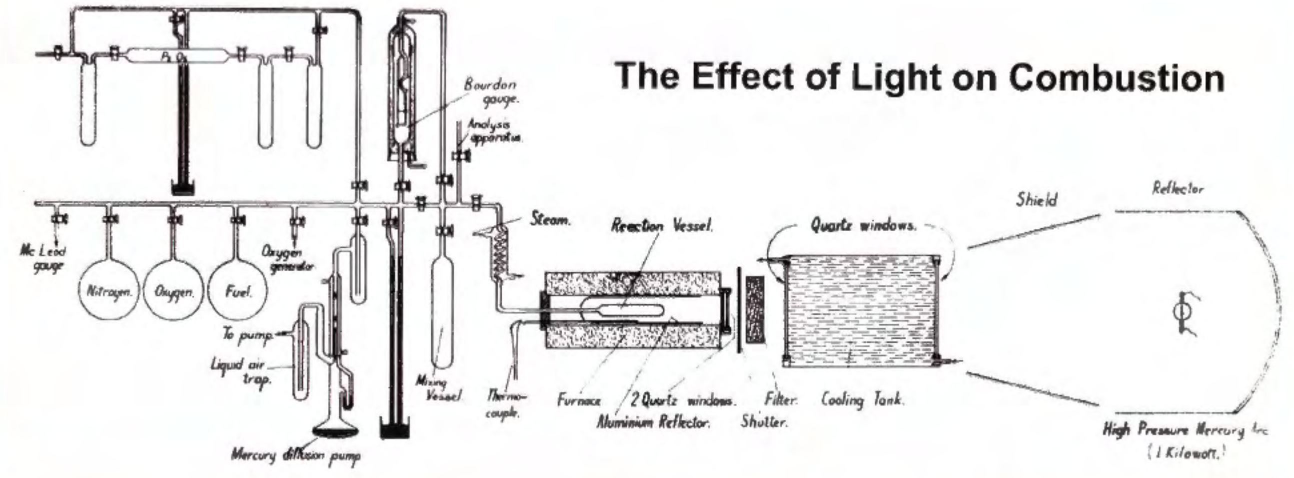

APPARATUS FOR PHOTOCHEMICAL REACATIONS

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